

Kaufman - Trading Systems & Methods - Chap14

Chap14

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14 Behavioral Techniques

There are some approaches to trading that are directly dependent on human behavior and cannot be represented by pure mathematics. When viewed in the short term, most systems will be more representative of behavior than economic factors because, over a few hours of one day, the longterm influence of the trend is very small. The concepts presented in this chapter deal specifically with human reactions. Measuring the news covers an area that has always been important to a floor trader, yet been greatly overlooked by technicians. it offers great opportunity for research. Event trading, which studies market reaction to price shocks, has become increasingly important for both proactive and reactive traders; contrary opinion takes the form of a poll or consensus of opinions of traders and market publications. It may help answer the question, "What is everyone else doing?", or at least, "What are they thinking of doing?"

The principal works of Elliott and Gann are included with a review of the Fibonacci series and ratios, which form a significant part of their technique. The way in which traders respond to market moves, and the remarkable similarity that can be found in Nature. give serious underlying substance to these methods. Because not all of the assumptions upon which these systems are based can be quantified, they are substantiated by the performance of the systems themselves. Both are fascinating and open areas of creativity essential to broad system development. They are grouped together with discussions of natural phenomena and the rapidly growing area of financial astrology, all of which should leave your grey matter stimulated.

MEASURING THE NEWS

If you can keep your head when all about you are losing theirs, maybe you haven't heard the news

Rudyard Kipling'

The news is one of the greatest single elements affecting free trade. As a medium, it carries both fundamental and technical information about all markets, directly or indirectly. and is indispensable. If not objective, the news services could materially alter any opinion by the inclusion or omission of relevant information. The impact of news is so great that a speculator holding a market position according to a purely technical system would do best not reading, listening to, watching, or in any sense being exposed to news that might be cause for deviating from the system. In a study commissioned by the Wall Street journal, it was shown that 99% of the financial analysts polled read the paper regularly, and 92% considered it the "most valuable" publication they read.

As an element of a trading program or as an indicator of its own. the news is invaluable. if we could measure the impact of unexpected news, the importance of the Wall Street Journal or the wire service articles, the USDA crop reports and the CFTC positions

'Adam Smith. The Money Game (Random House. New York. 1967 p. 48).

' Firebrick C. Herein and John A. Prestbo, Neu,s and the Market (Henry Regnery. Chicago. 191. p. 3)

reports,' and the anticipation of news, we would have a better view of the direction of the markets. But first we must be aware of the complications of analyzing the news. There is the problem of objectively selecting which items are relevant and which sources are most important. The most difficult problem is quantifying the newshow do you rank each item for measurement, and on what scale do you determine cumulative importance? Some news items are known to have a greater impact on the marketweather disasters, major trade agreements, key crop reportsbut these must be ranked against themselves and other issues to produce a numerical system of analysis. On a single day, an address by the President about foreign trade may be ranked as a +6, a meeting of the Federal Reserve a +7, unemployment a +4, the NAFTA Agreement a +3, a continued lack of rain in the west as a +2, large grain stocks as a 4, and a key article in the Wall Street journal on the improved Russian crude oil production as a 5, giving a net score of +4 to the newsinterpreted as moderately bullish. Such a ranking scheme would be considered analytic in nature, because it tries to weigh relevance on a predetermined scale without knowledge of individual effects.

Klein and Prestbo attempted such a study by assigning values of 3, 2, and 1 to articles in the Wall Street journal of decreasing importance. Their interest was the stock market, and their work was straightforward and some of the conclusions general in nature. They showed a direct correlation between the relevant positive and negative news articles and the direction of the stock market. As it was scored over 6week intervals before and after major turning points in the DowJones Industrial Averages, the news would stay about 70% favoring the current market direction. Having eliminated the possibility of the market influencing the news, they could conclude that, in retrospect, the market reflected the nature of the news.

The focus of news that influences commodity prices is different from that which moves the stock market, because it is limited in scope and often specific to the particular physical market. News releases and economic reports are an implicit part of commodity pricing, newspaper releases become very important in the last phase of a long move, which is easily seen when weather is a primary factor, but also when trade agreements are being negotiated. For example, traders will watch the weather report beginning in June when there has been a shortage of rain. They will stay long while no rain is in sight and quickly sell if a thunderstorm develops over the Chicago Board of Trade building. They will also protect their positions going into the weekend, in the event of unexpected rain, then reset their net longs on Monday. The news items that affect prices the most are:

Release of economic statistics (inflation, sales, balance of trade, unemployment)

Action by the Federal Reserve or other central bank

News relating to the availability of funds

Government reports on production and stocks

Unexpected news (a potential price shock such as an assassination)

Trade negotiations, agreements, and legislation

Weather

Indepth studies by the Wall Street Journal

Frontpage news articles (or lead television news) on high prices, strikes, and other topics with a direct economic impact

Market letters, research reports, and comments from accepted authorities and influential organizations

3 A thorough analysis of the CFTC Commitment of Traders report can be found in Chapter 16 It should be noted that other government reports released on the same day may complicate the interpretation.

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Ranking and Measuring

The problem of ranking and assigning values to news items requires a knowledge of how others see the news. Klein and Prestbo studied this problem for the stock market and concluded that about 90% of the Wall Street Journal readers perceived news in the same way (bullish, bearish, or neutral). The same relationship can be assumed for futures markets. A reason for the uniform interpretation of the news articles is the publicized analysis. Within minutes of the release of an economic report or Fed action, the wire services begin to quote independent and poll opinions of the meaning of the report, then transmit those interpretations over their news media to be relayed to most traders. The professional analysis is taken as correct, and later discussions based on that interpretation serve to solidify the opinion.

News can also be measured empirically, by studying the immediate impact of an expected or surprise news item. For statistical reports, such as the Producer Price Index, care must be taken to use the correct figures. Market reaction is a combination of expectations compared with actual figures, and corrections in the previous month's data. In some months it is difficult to know whether the jump in prices was due to a downward revision of the previous month, or current values that are lower than expectations. When testing these factors, the historic data must include the actual numbers released in the reports, and a separate value for the revision of the previous month. Industry expectations are also important, but they can be determined empirically from the market's reaction. Therefore, following the release of an economic report, we can expect the price change to be expressed as:

$$\text{Price change} = (a(\text{current value} - \text{expectations}) + b(\text{revision previous value}))$$

where a and b are weighting factors, $a > b$ implying that the current value is more important than the previous one. It is necessary to make the assumption for this type of measurement that the effects of a news release are most important in the short term, and that their influence on the market is diluted daily. A starting point for representing the way in which the news decreases in value is to modify the standard physics formula:

$$I = \frac{1}{T^2}$$

where I is the net influence and T is the elapsed time since the release of the news. In science this relationship, which represents the

physical impact declining with the square of the distance (or time), applies directly to sound and light.

Measured empirically, the impact of economic reports is worth studying. For futures markets, the CFTC releases its Commitments of Traders report each week (upgraded from monthly reports). it tells the distribution of holdings among large and small speculators and hedgers as a percent of total open interest. This report is watched with the idea that the small speculators are usually wrong and the large hedgers right (this is covered in a later section of this chapter).

It is important to understand the difference between the analytic and empirical approach to news. In the analytic method, the value of specific events is determined in advance, and when they occur their preassigned value is compared with the effects. Using the empirical method, the historic effects of each event are tabulated and measured, then applied to subsequent news items.

The analytic approach has the advantage of working in an environment where multiple events are occurring simultaneously, and only the sum of all news items can be calculated. When testing the empirical approach, the event of interest may not be clearly distinguished from other news of importance occurring at the same time. Finding situations that isolate a

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single type of event, from which you can measure its impact, may be impossible. The primary disadvantage of the analytic approach is that it does not account for the discounting or anticipation of the news. An event of modest importance may become neutral or more significant relative to other concurrent or anticipated events; the empirical method would not be subject to that problem since it measures reactions and not expectations.

Trading on the News

Even without a sophisticated method of measurement, there are many professional speculators who trade on the news. When a bullish news item or report is introduced and the market fails to respond upward, the experienced trader looks for a place to sell. it shows that expectations exceeded reality and prices had already anticipated the bullish interpretation of the news; there may be a large number of sellers above the market. Similarly, opening calls, available for most markets, are transmitted via wire services beginning about a half hour before the opening bell. Regardless of the means for determining the opening direction, an experienced trader may take advantage of a higher opening call to place a sell order. There are frequent cases of so many traders wanting to sell a higher opening that the influx of orders after a call, before the opening, has changed the direction from higher to sharply lower on the open.

Agricultural weather markets function purely on news. Traders with long positions wait for the 5day forecast hoping for no rain., they anticipate a loss of a specific number of bushels per acre for every dry day once the rainfall is below a given level. Weather markets are nervous and are characterized by eveningup on weekends., they rely heavily on

anticipation and emotion. It is said that a farmer loses his crop three times each year: once for drought, once for disease, and once for frost. In 1976, the news carried numerous articles on the desperate wheat crop in the western states, showing films of virtually barren fields, and yet the United States harvested one of their largest wheat crops on record. Weather markets have a history of volatile anticipation but are a risky way of making longterm price predictions.

The discounting of news is as important as the news itself. An old saying in the market, "Buy the rumor, sell the fact," implies that anticipation drives the price past the point where it would realistically adjust to news. When the actual figures are released, there is invariably an adjustment back to their proper level. The pattern of anticipation for each economic report or news event should be watched closely.

Market Selectivity

The market seems to focus on one news item at a time. Although the same factors are always there to affect prices, they must reach a point of newsworthiness before they become the primary driving force. For heating oil, the combination of unexpected, sustained cold weather compared with available inventories will activate a weather market. Interest rates, the U.S. dollar, and tension in the Middle East will either be magnified out of proportion or completely ignored, while the anticipation of demand rises sharply. A market analysis of shortages not supported by news may as well be discarded; it is more often that crowd behavior moves the market.

Media Indicators

In a delightful article,⁴ the author Grant Noble argues that the news recognizes events when they are cresting, and most often provides a countertrend trading opportunity. First, the American media should be considered to provide signals in three major time frames:

4 Grant Noble, "The best trading indicator: the media," *Technical Analysis of Stocks & Commodities* (October 1989).

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- Longterm as given by the large circulation news magazines such as *Time* and *Newsweek*. With the timeliness of a brontosaurus, they profile moves over many years.
- Medium term represented by *Barron's*, *Forbes*, and *Business Week*, cover a period of about 3 months.
- Short term held captive by the *Wall Street Journal* and the *New York Times*, which also provide intermediate prediction.

By reading these periodicals you find that the *Wall Street Journal* has run headlines on "killing drought," "dust bowl," and the *New York Times* on "Drought ... imperils crucial wheat crop" just as the wheat price makes its highs for the current move. In another case, *Barron's* cover article asked "Is the bull leaving you behind?" in August 1987. It's not surprising that the media would highlight events only after they have become a popular concern. In that sense, we might say that there is a high public consensus, a topic addressed in the section "Contrary Opinion." It may be perfectly valid to construct a consensus indicator based on the number of square inches of news coverage given to an event in a combination of publications.

EVENT TRADING

The largest price moves and the greatest volatility are the result of reactions to unexpected news. These market events pose the greatest risks to all traders because they are unpredictable and of such great magnitude that they are out of proportion with normal trading risk. It may be possible to trade for a number of years without experiencing an adverse price shock., therefore, many traders do not plan properly for these situations. Those readers interested in price shocks and their effects should also refer to Chapter 21 ("Testing").

Not all price shocks are of such magnitude that they present an unmanageable problem. it may be that price moves are either the reaction to news or the anticipation of news. This news is most often a release of an economic report by a government agency or monetary authority, but can also be a natural disaster associated with weather or earthquakes, or a political event, such as an outbreak of war, a military coup, or an assassination. The U.S. government releases economic data on an announced schedule, many of them at 7:30 A.M. Chicago time, that create regular disruptions to price movements in world economic markets.

The frequency and size of these price moves, triggered by unexpected news, makes these events a natural candidate for a trading system.' The profit opportunity, however, does not lie in taking a position ahead of the anticipated market reaction, but in studying the systematic patterns that come after the initial price reaction to the news. Because the news is unexpected, you cannot predict the results nor the extent of the reaction; therefore, taking a market position in advance of a government report would have a 50% chance of success and often very high risk. Studies might show that there is a bias in the direction of the price shock due to the way the monetary authority plans economic growth and controls inflation; however, the risks would remain high. This section win only look at positions entered on the close of the event day, the day on which a sharp market reaction occurred.

Market Reactions to Reports

To determine whether there is ample opportunity to profit from the price move that follows an event, it is necessary to study the direction of the market move and the subsequent price changes that occur over the next few days. These lagged reactions are the results of market inefficiencies; it is unlikely that prices could immediately jump to the exact price

1 Ben Warwick, *Event Trading* (Irwin, 1996).

that economic principles require, despite the Efficient Market Hypothesis. With large price shocks there is often an over or underreaction that is corrected during the next few days. Sometimes prices jump one direction and immediately begin to go the other way until they have completely discounted the price shock.

Figure 141 illustrates the types of price movements that might follow an upward price shock. Where there is an underreaction the prices move higher over the next few days; when there is an overreaction prices move lower. Patterns are not as orderly as shown in Figure 141 because volatility is high and many traders react impulsively, or by financial

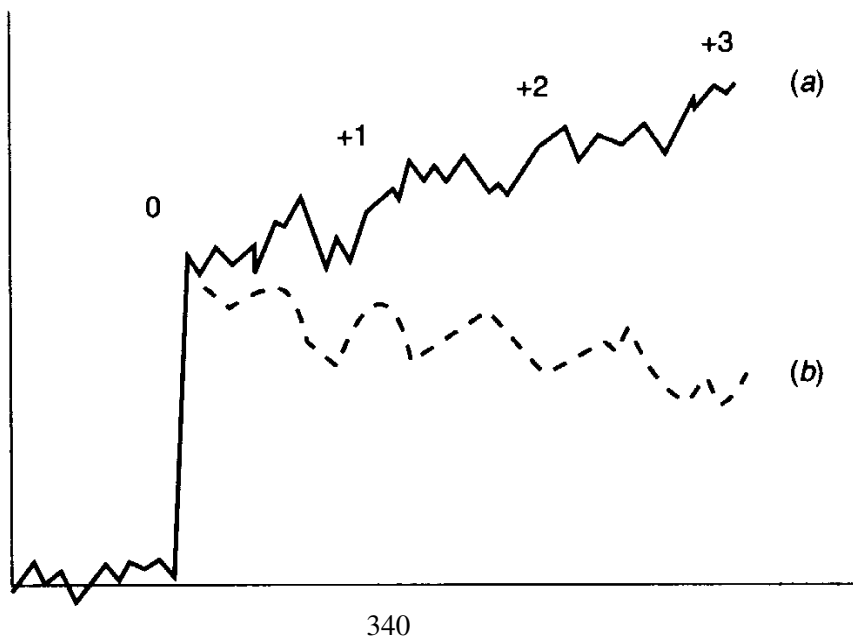
necessity, to the move. To decide whether a market is a candidate for event trading, you must study the pattern of moves following the reaction to news and decide whether:

1. The size of the average move is enough to generate a profit.
2. The returns are worth the risk of loss associated with these volatile events.

When studying these events, there may be a direct relationship between the size of the reaction and the type of pattern that follows. For example, a small reaction to news may be followed by a steady continuation of the direction of the price shock. If unemployment jumps by $1/4\%$ in a month, there should be a reaction by the government to stimulate job growth. The same initial reaction would occur if unemployment jumped by 1 full percent, but the number would be so unexpectedly large that it may be considered an error in which case it is not clear to what extent the government would respond. The market may overreact to a large shock but underreact to a small one. The only way to discover this is by testing these events.

Fundamental to understanding price shocks is that the shock is based on the difference between the expectations and the actual reported data, not just the reported data. The market always discounts what it believes is its best guess at what the report will say., therefore, if bond prices rise in advance of an important unemployment report, we can say that the market expects unemployment to increase. If bond prices have moved up by $1/2\%$ (equivalent yield) in expectation of a very bad report, and the report comes out neutral, then prices will drop sharply to offset the incorrect anticipation. When studying market reactions from historic records of economic data, you must have market expectations to

FIGURE 141 Price reaction to unexpected news, including delayed response. The upward price jump on the event day (0) may be followed by (a) a continuation move up or (b) a reverse move down over the next 3 days.



find consistent results; without those values, the best approach is to work backward from the reaction to infer the accuracy of expectations.

Measuring an Event

There are many economic statistics released each year, as well as special reports in the wall Street Journal and other influential periodicals. To record the dates of each news item would be impractical for most traders. a simpler approach that might prove effective is to identify the importance of the event by the size of its reaction. This can be done by comparing the volatility of the current day with the average volatility of the recent past, using the true range calculation:

$$\text{volatility ratio} = \frac{\text{true range}_{\text{today}}}{\text{average true range}}$$

When the volatility ratio is below 1.0, current volatility is less than the average volatility over the past n days. When the ratio is greater than 3.0 we are likely to have identified a day in which a news event caused a price shock. The larger the ratio, the greater the surprise to the market. Note that the true range is used because the shock can occur overnight, causing an opening gap, or during the trading session, when the United States typically releases reports.

Key Government Reports

Even when there is public concern over the state of the economy,

the market does not react in a similar way to all economic data. Some reports seem to be more important than others, and the market appears to focus on one report at a time. The most significant data seem to be unemployment and the Consumer Price Index (CPI). During a period of sustained low unemployment, as seen in 1997, even a modest increase will not cause much concern. A jump in the CPI, however, will always warn the market to expect a preemptive strike by the Fed, cutting off potential inflation by nudging rates up slightly. The Trade Balance report was particularly popular in the late 1980s when the deficit with Japan seemed to be at the root of the U.S. deficit. Sagging U.S. exports and overconsumption of foreignmade products by Americans looked as though the U.S. work force could not compete in the world market.

Other reports can also attract the attention of traders, but may be more difficult to interpret. Durable goods, retail sales, budget, and tax legislation all directly affect the economy and prices; however, it is not always clear how to relate the changes in durable goods orders with price change, or how the latest news on tax law will contribute to the economic wellbeing. More important, it is difficult to assess how the government will manipulate interest rates in reaction to these data.

Trading the Event Lag

Once you have studied the way prices move following an event day, or price shock, you can establish trading rules. For example, you find that a change in the Consumer Price Index of between 0 and .2% has no particular reaction, provided market expectations were similar to the data released. A change between +.2 and +.4 or .2 and .4 should give enough surprise for a noticeable market reaction, provided expectations were low, and data greater than a change of $\pm .4$ should cause a price shock regardless of the anticipation. In addition, we might find that changes over $\pm .4$ tended to react in the opposite direction to the normal government action because of overanticipation.

Based on the results of studying these patterns, Warwick established the following trading rules:

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1. Buy on the close if the market closes in the upper 20% of the trading range on an event day (a price shock), if prices have shown a continuation pattern.
2. Hold for a predetermined number of days, based on the lag pattern of the market.
3. Use a stoploss to limit risk.

in an older study by Arnold Larson' applied to the corn market, it was found that 81% of the price changes occurred on the event day, there was a typical price reversal of 8% over the next 4 days, and a net change in price of 27% in the original direction over 45 days. Although we should not expect those same numbers now, the pattern of a large move, a reaction, and a longer directional move may still be valid.

Results of Event Studies

In his book *Event Trading*, Warwick shows the test results of some of the major markets, allowing us to compare the effects of the systematic

reaction of U.S. bonds with that of the S&P 500 and other markets. Unexpected news that causes bond prices to rally sharply (causing rates to decline) would result in a rise in the stock market, unless the news was particularly bad for the longterm economy of the country. Therefore, a drop in the consumption of durable goods should be followed by lower interest rates and a slightly lagged upward response in the stock market. This pattern is shown in Table 141 where the bond and S&P results are sidebyside.

In general, we expect a price shock to impact interest rates first, then currency and equities markets. Typically, the interest rates react in a way to compensate for the economic effects and stabilize the other two markets; this preempts the action that would be expected from the Central Bank. The exception is when the news is much more extreme than usual, and it affects the stock market first. Investors, because of a lack of confidence, will shift their funds from equities to interest rates in an effort to find a safe haven during uncertainty. This will cause a decline in the stock market and a corresponding rise in interest rate prices (lower yields), although normally the two will move in the same direction.

In Table 141 we can see the way the markets move after both the interest rates and stock market initially react with an upward price breakout. When both markets continue in the same direction, such as with retail sales, GDP, and employment data, then the full impact of the data takes longer to be assessed by the market, or there is expectation of

6 Arnold Larson, "Measurement of a Random Process in Futures Pricing," Food Research Institute Studies 1 (no. 3, November 1960, referenced in Warwick, Event Trading).

TABLE 141 Results of Upward Breakout of U.S. Bonds (left) and S&P 500 (right) for the Period 1989-1994

	U.S. Bonds			S&P 500	
	Holding Period	Buy or Sell	Confidence Level	Holding Period	Buy or Sell
Durable goods	0-1	B	97	0-4	B
Retail sales	0-1	B	90	0-2	B
Retail sales	1-5	S	95	2-4	S
CPI		Low confidence		0-3	B
PPI	0-5		95	0-1	B
NAPM	0-2		91	0-4	S
Industrial production	0-1	S	94		Low confidence
GDP	0-3	B	90	0-4	
Employment	0-2	B	91	0-1	

some continued response by the government. The PPI and the National Association of Purchasing Managers (NAPM) do not show this consistency, indicating that the market takes this information differently. When the pattern of confidence is low, the market may do a good job of reaching the best price level in immediate response to the news; therefore, there is no consistency in the price move that follows.

Table 142 shows the sidebyside test results of reactions that cause a

drop in bond prices and a corresponding drop in the S&P 500. The frequency of low confidence results may represent the conflict between the normal upward bias of the stock market or the unusually bullish trend during the test period. The GDP results, which show the most confidence, indicate that the stock market moves higher even when the interest rates rise in reaction to positive GDP data. Trade balance data, which is not always the primary focus of the market, has a very consistent pattern, but is not clearly related to the interest rate move as are most of the other statistics.

Although this work concentrates on the shortterm daily reaction to unexpected news, the longterm trend should not be overlooked. Economic data can exhibit consistency over long time periods, and the response by the Central Bank is usually moderate but consistent. If the CPI shows early signs of inflation, then the monetary authority will push rates up slightly; if this doesn't work, as seen by the next series of economic reports, they will move rates slightly higher again. This pattern allows for an underlying trend that can be used to filter the direction of trades and add confidence to the results.

Reaction to Unemployment Reports

Markets treat unemployment data seriously; because it is a direct reflection of how the population is faring, the government is sensitive to unexpected changes in the number of persons filing for unemployment benefits. Using LIM, it was found that when the market underestimated the unemployment figure by at least 0.2%, there was an average return of 4.5% in the S&P 500 during the following 27 days from the close of the report day. Similarly, U.S. 30year Treasury bonds showed an average return (from a long position) in nearly all cases of 3.2% during the period from 3 to 28 days following the report.'

¹Gibbons Bunks, "Eventbased Analysis," Futures (April 1995).

TABLE 142 Results of Downward Breakout of U.S. Bonds (left) and S&P 500 (right) for the Period 1989-1994

U.S. Bonds			
	Holding Period	Buy or Sell	Confidence Level
Durable goods		Low confidence	
Retail sales		Low confidence	
Retail sales		Low confidence	
CPI	0-4	S	97
PPI		Low confidence	
NAPM		Low confidence	
Industrial production	0-4	S	93
GDP	0-3	S	91
Industrial production	3-4	B	>99
Employment	0-1	S	93
Trade balance	0-3	S	93

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Presidential Election Cycle

of all the events that move the market, the Presidential elections have been the most consistent. The patterns stem from the motivation of the incumbent party to provide good economic news to the voters prior to the election year, and as far into the election year as possible. Stock market action during the election year is always more erratic, as parties battle over the value of each other's actions.

Studies of the 4year patterns have all yielded very similar results to those shown in Table 143.' The year preceding the election (year 3) posts the strongest gains for the market, followed by a reasonably strong election year. The 2 years after the election show returns below average as the reality of politics reasserts itself.

There is the additional possibility that there is an 8year cycle that should be watched; however, the 8year period should be most informative if it represented only those years in which the same President was in office. Actions by a President who cannot be reelected are likely to be different from one who seeks another term; therefore, we should expect a different pattern. This can be made more intricate by studying the patterns preceding and following a change of party, all of which have a fundamental basis in the behavior of the political parties and the voters.

More sophisticated computer software, such as provided by Logical Information Machines, a Chicago firm, can produce a very interesting, closer view of how voters respond to election politics. Table

144 breaks the election year into periods between the key events for those years in which the stock market began the election year within 8% of its 2year high price (days refer to business days):

- 1. The returns of the year preceding the election year
- 2. The first 10 days of the new year, typically a strong period (days 010)
- 3. Through the StateoftheUnion address and the primaries (days 1083)
- 4. Waiting for the conventions (days 83161)
- 5. Preelection blahsthe actual campaign (days 161195)
- 6. The election to yearend reaction (days 195253)
- 7. Combined periods (2) + (4) + (6)

Combining the three periods (2), (4), and (6), which have strong upward biases, gives consistently positive results. Even if the newly elected party fads to deliver on their campaign promises, traders could have already converted those marketing gimmicks into stock market profits.

'Articles by Adam White, "The EightYear Presidential Election Pattern," Tecimical Analysis of Stocks & Commodities (November 1994); Arthur A. Merrill, "The Presidential Election Cycle," Tecimical Analysis of Stocks & Commodities (March 1992); and Michael J. Carr, "Get out the vote and into stocks," Futures (February 1996), all show very similar results for the 4year election pattern.

TABLE 14-3 The Presidential Election Cycle, 1912–1992, Based on the Percentage Returns of the Dow Jones Industrial Averages

Preelection year	11.0%
Election year	7.0
Postelection year	4.7
Midterm year	2.3
Average year	6.3%

Source: Adam White.

Year	1. Previous Year	2. First 2 weeks (1-10)	3. Primaries (10-83)	4. Preconvention (83-161)	5. Preelect (161-183)
1936	41.82	2.76	4.64	11.91	-0.62
1944	19.45	1.63	-.84	9.27	-.86
1952	16.15	1.60	-2.82	8.02	-2.49
1956	27.25	-1.78	5.42	3.16	-6.65
1960	8.48	-2.49	-5.75	2.94	-7.13
1964	18.89	1.79	4.44	3.03	2.52
1968	20.03	0.26	-0.10	1.44	4.39
1972	10.82	1.41	3.39	5.30	-1.78
1980	12.31	2.26	-5.42	18.57	-0.20
1984	17.53	1.27	-5.01	4.27	0.41
1992	26.30	0.80	-2.72	2.14	-0.23
Average	19.91	0.86	-0.44	6.37	-1.15

Source: Michael Carr. *Logical Information Machines*.

COMMITMENT OF TRADERS REPORT

Drawing from more than 20 years of experience in analyzing the CFTC's Commitment of Traders Report, William L. Jiler described a supplementary approach to identifying a major trend in his 1985 CRB Commodity, Yearbook.' With his usual thoroughness and clarity, Jiler presents material that had previously been unsuccessfully interpreted.

Originally released the 11th day of each month (biweekly since 1992), the Commitment of Traders Report summarizes the positions of reporting and nonreporting traders as of the last day of the previous month. Reported positions are those exceeding a minimum determined for each futures market (e.g., 50,000 bushels for corn, 500,000 for soybeans, 500 contracts for 30-year Treasury bonds, and 300 contracts for the S&P 500). The report subdivides the open interest into positions held by hedgers (commercials) and speculators. By subtracting the reported positions from the total open interest, the total positions of small hedgers and speculators can be found. For grain reports (Figure 112), positions are further divided into old crop and other positions, which include new crop and intercrop spreading. To analyze the shifts in position, Jiler has compiled tables of normal patterns, similar to a seasonal study (Figure 143). When the open interest of one group is significantly greater than their normal holdings, they express a definite opinion on the direction of the market. By tracking these changes for many years and observing the corresponding price changes, Jiler concludes that the large traders have the best forecasting record, with the large hedger better than the large speculator. The small traders were notably worse. Guidelines were stated as:

The most bullish configuration would show large hedgers heavily net long more than normal, large speculators clearly net long, small traders heavily net short more than seasonal. The shades of bullishness are varied all the way to the most bearish configuration, which would have these groups in opposite positions large hedgers heavily net short, and so forth. There are two caution flags when analyzing deviations from normal. Bewary of positions that are more than 40% from their longterm average and disregard deviations of less than 5%.

William L. Jiler. "Analysis of the CFTC Commitments of Traders Reports Can Help You Forecast Future,; Prices.

1985 CRB

Year Book (Commodity Research Bureau. Jersey

ierscs. City NJ 1985).

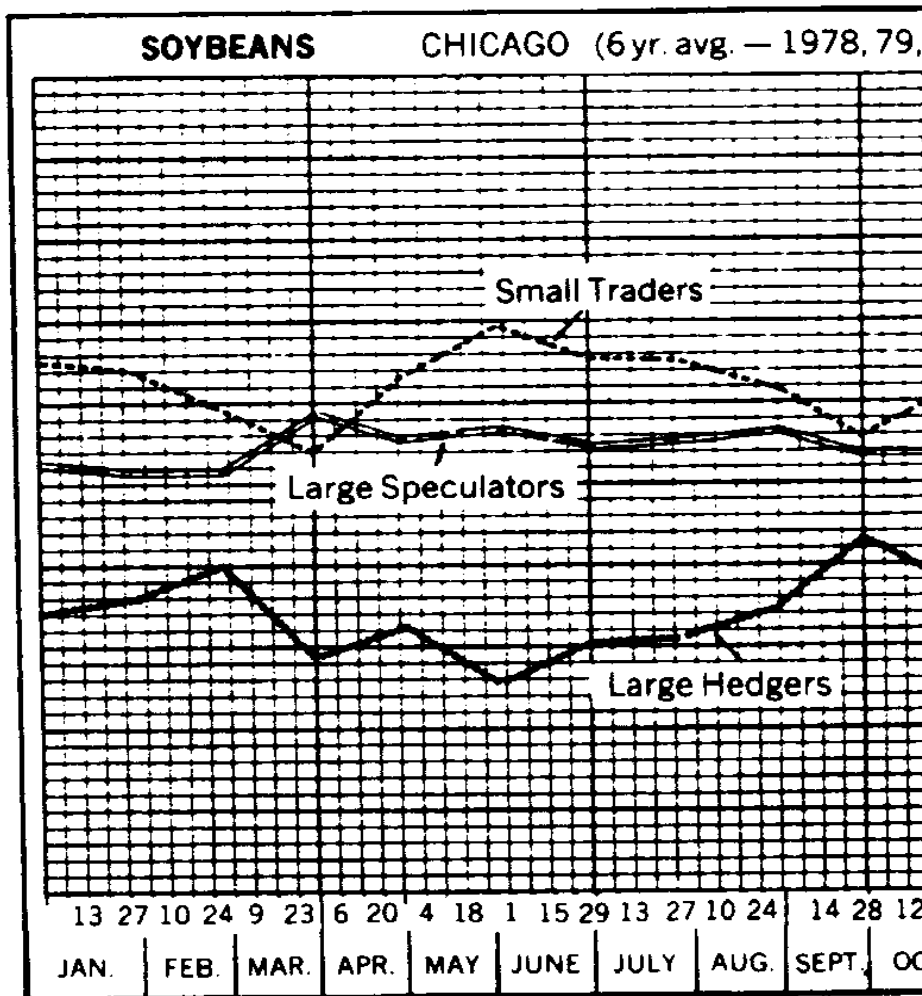
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FIGURE 142 Commitment of Traders Report.

SOYBEANS - CHICAGO BOARD OF TRADE
COMMITMENTS OF TRADERS IN ALL FUTURES COMBINED

F U T U R E S	TOTAL	REPORTABLE POSITIONS				
	OPEN INTEREST	NON-COMMERCIAL				COM MERCIAL
		LONG OR SHORT ONLY		LONG AND SHORT (SPREADING)		
		LONG	SHORT	LONG	SHORT	
		(THOUSAND)				
ALL	359,190	15,810	32,400	41,060	41,060	117,130
OLD	302,170	16,275	35,075	27,620	27,620	105,345
OTHER	57,020	9,280	7,070	3,695	3,695	11,785
ALL	-330	-9,240	15,575	18,280	18,280	16,285
		CHANGES IN COMMITMENTS FROM				
		PERCENT OF OPEN INTEREST REPRESENTED				
ALL	100.0%	4.4	9.0	11.4	11.4	
OLD	100.0%	5.4	11.6	9.1	9.1	
OTHER	100.0%	16.3	12.4	6.5	6.5	
		NUMBER OF TRADERS				
		NUMBER OF TRADERS IN				
ALL	144	23	32	33	33	
OLD	134	23	32	23	23	
OTHER	32	8	8	5	5	
		CONCENTRATION				
		PERCENT OF OPEN INTEREST HELD BY THE				
		BY GROSS POSITION				
		4 OR LESS TRADERS		8 OR LESS TRADERS		
		LONG	SHORT	LONG	SHORT	
ALL	13.0	23.4	18.1	28.6		
OLD	13.9	25.0	19.6	30.4		
OTHER	18.6	20.6	27.4	28.7		

FIGURE 143 Jiler's normal trader positions.



This result is confirmed by Curtis Arnold, who compared positions of large and small speculators with commercials for a year period spanning 1983-1984. Arnold shows (Figure 144) that the position of commercials and small speculators tend to be opposite, with the commercials positioned to profit from the subsequent price move.

Over a wider group of 36 markets from 1983 to 1989, a study conducted by Bullish Review showed that a large weighting of long or short positions held by commercial hedgers correctly forecasts significant market moves 67% of the time. In retrospect it seems likely that a large commercial trader, bank, investment house, or other institution would take a longerterm view of the market, setting positions to take advantage, or avoid the risk, of a potential price move. Because of their size, institutions

are not likely to change their positions on minor market variations. Analysts should be aware, however, that a qualified hedger, one that is registered with the CFTC to set large positions due to their ongoing risk of holding physicals, may also take large speculative positions under the same umbrella.

OPINION AND CONTRARY OPINION

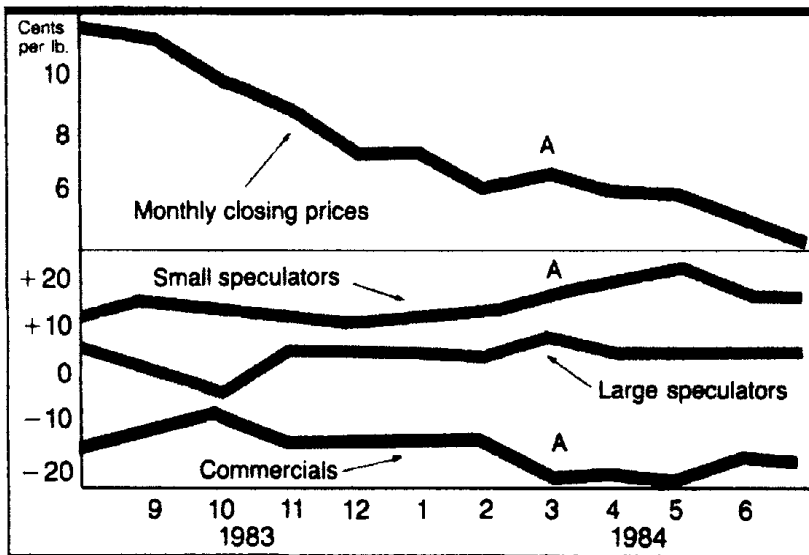
Market sentiment seems to be a driving force in the market, yet it is very difficult to measure and even harder to deliver those results in a timely fashion. For that reason, analysts often substitute a combination of volume, open interest, and price for true sentiment, hoping that the recorded actions of traders closely relate to what they are thinking. Opinion, however, weighs on the marketplace and governs future actions in the same way the high volume may not move prices today, but provides a platform for a potentially large price move.

Public opinion is also fast to change. A prolonged bull market in stocks may show a gradual increase in bullish sentiment; however, the collapse of a bank, an increase in rates by the Central Bank, a sharp downturn in the economy of another region, or a single sharp drop in the stock index could quickly change the public's opinion. Oddly enough, sentiment indicators are most popular for trading in the direction opposite to the unified public opinion.

¹Curtis Arnold, "Tracking 'Big Money' May Tip Off Trend Changes," *Futures* (February 1985).

¹ Steve Brieze, "Tracking the big foot," *Futures* (March 1994).

FIGURE 144 Arnold's trader position study.



SUGAR

Contrary Opinion

The contrarian lies somewhere between the fundamentalist and the technician, basing actions on the behavior of crowds, in this case the market participants. The contrarian sees the end of a bull market occurring

when everyone is bullish. Once all long positions have been set, there is diminishing influence by the bulls; moreover, opportunities always lie in the reverse direction from crowd thinking.

Contrary opinion alone is not meant to signal a new entry into a position; it only identifies situations that qualify. It lacks the timing. It is more of a filter than a trading system, a means of avoiding risk and finding an opportunity. Consider the patterns that appear in every prolonged bull or bear move. First, there is a place where the direction is generally accepted as the major trend. After that, traders wait for a reversal to enter in the direction of the trend at a more favorable price. These price corrections become smaller or even disappear when everyone wants to buy a lower open or sell a higher open until you have the ultimate blowoff and a reversal of a major bull or bear market. The dynamic end of a prolonged move is generally credited to the entrance of the public; when the masses are unanimously convinced that prices are going higher, who is left to buy?

The other important ingredient for a contrarian is that all the facts cannot be known. The widely accepted belief that "prices will go higher" must be based on presumptions; if the final figures were out, the market would adjust to the proper level. This idea is older than *The Art of Contrary Thinking*. In 1930, Schabacker discussed cashing out of a long position if the market rallied on news that was general rather than specific.

The practical application of the theory of contrary opinion is the Bullish Consensus and the Market Sentiment Index, created from a poll of market letters prepared by the research departments of brokerage firms and professional advisors. In the Bullish Consensus (see Figure 145), these opinions are weighted according to the estimated circulation of these letters until a final index value is determined.

Bullish Consensus = $\text{Sum of (each source} \times \text{its relative weight} \times \text{opinion)}$

$\text{Sum of (each source} \times \text{its relative weight} \times \text{bullish opinion)}$

The value of the Bullish Consensus will range from 0 to 100%, indicating an increasingly bullish attitude. Because of the bullish tendency of the novice trader, and the longterm upward bias of the stock market, the neutral consensus point is 55%. The normal range is considered from 30 to 80%, although each market must be individually evaluated.

Hadady also devised a simple mathematical way of displaying the bullishness of the market. Using the formula below, he shows that when 80% of traders are bullish, then the average buyer will hold only 1/4 the number of contracts as the average seller. This leads to a precipitous drop in prices once a decline begins.

$$N_t = \frac{20\% T \times N_s}{80\% T} = \frac{1}{4} \times N_s$$

where T = the number of traders in the market

N_t = average number of contracts held by a single trader

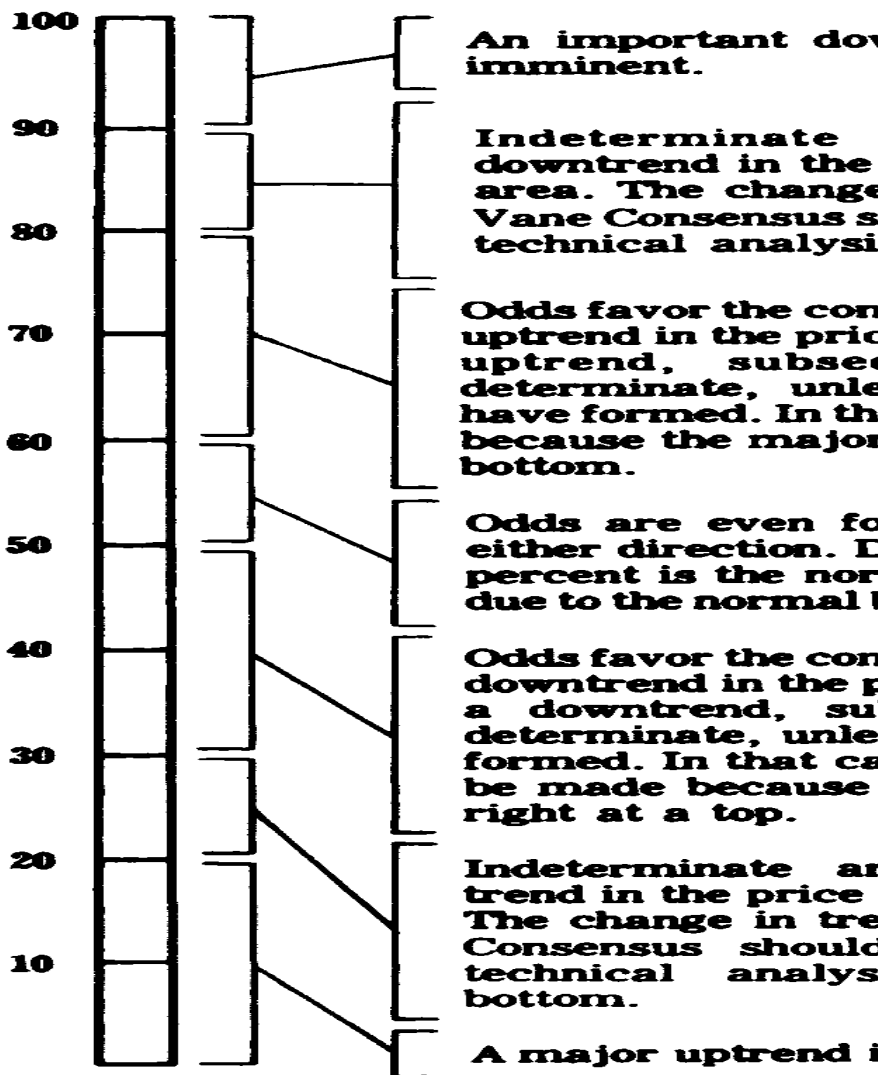
N_s = average number of contracts held by a single speculator

^ For the most definitive works, see Humphrey Neill, *The Art of Contrary Thinking* (Caxton Printers, Caldwell, OH, 1960), who is credited with having first formulated the concept, and R. Earl Hadady, *Contrary Opinion* (Hadady, Pasadena, CA, 1983).

" The Bullish Consensus is a product of SibbettHadady, Pasadena, CA; a Market Sentiment Index is published in *Consensus*, Kansas City, MO.

" R. Earl Hadady, "Contrary Opinion," *Technical Analysis of Stocks & Commodities* (August 1988).

Bullish Consensus Percentage



Source: R. Earl Hadady, *Contrary Opinion* (Pasadena, CA: Hadady, 1983).

The principle of contrary opinion does not require that trades only be entered in the direction opposite to the current price movement. Within the normal range, the contrarian will take a position in the direction of the trend. Frequently, the Bullish Consensus will begin increasing prior to the price turning higher, indicating that the attitude of the trader is becoming bullish. It is considered significant when the index changes 10% in a 2week

period. Once the Bullish Consensus reaches 90% during an upward move, or 20% during a bear move, the market is considered overbought or oversold, and the contrarian looks for a

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convenient point to exit from the current trade. Positions are not reversed until prices show that they are not continuing in the original direction. This could be identified using a moving average. Remembering Schabacker's advice, the occasion of a general news release that moves the market further in the direction of the general opinion would be an opportune moment to enter a contrary trade; specific news that fails to move prices would be a good indication of an exhausted trend when the consensus is overbought or oversold. A typical contrarian situation identified by Hadady is given in Figure 146.

R. Earl Hadady said: "The principle of contrary opinion, by definition, works 100% of the time. The problem is getting an accurate consensus." Timeliness is a problem with this index; if 60 to 70 market letters are reviewed, read, and weighted to form an index, the results may be outdated before they can be used. The theory of contrary opinion also emphasized its use as a timing device for entering trades at an opportune moment and for filtering out the ambiguous trades; the theory is not readily applicable to exiting a position unless the reverse consensus occurs. Because a consensus does not have to switch uniformly from bullish to bearish, it is not always prudent to wait for an opposite confirmation before exiting a trade.

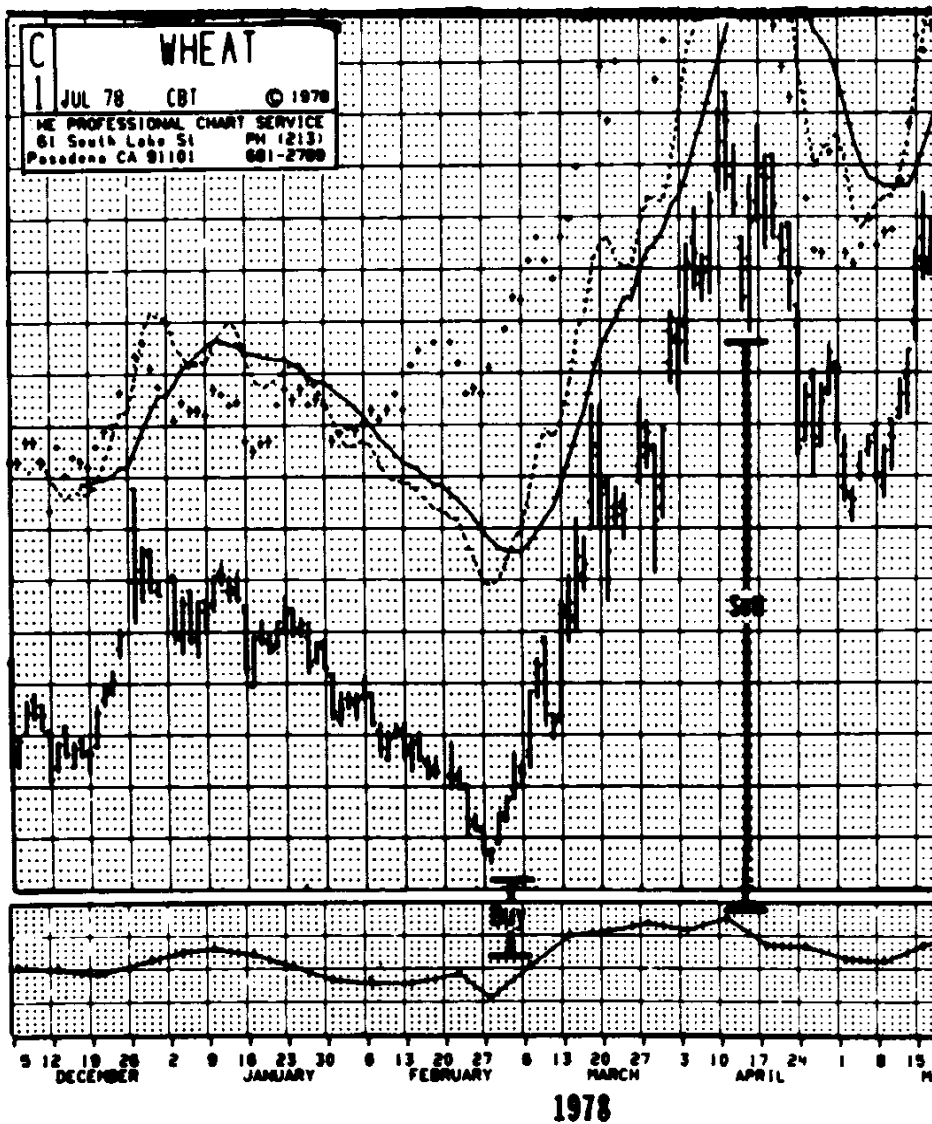
Commitment of Traders Sentiment Index`

The reported positions of traders, published in the CFTC's Commitment of Traders Report, may be considered a recording of market opinion into categories. By combining

George Angell, "Thinking Contrarily," *Commodities* (November 1976).

Stephen E. Briebe, "Commitment of Traders as a sentiment index," *TecAmical Analysis of Stocks & Commodities* (may 1990).

FIGURE 146 Typical contrarian situationwheat, 1978.



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the idea behind the stochastic calculation with a method originally developed by Curtis Arnold, you can create an index:

$$\text{Commitment of Traders Index} = \frac{\text{current net} - \text{minimum net}}{\text{maximum net} - \text{minimum net}}$$

where: Net = Commercial net position (number of contracts) minus the total combined net position of

large speculators and small traders

Maximum = Greatest net difference that occurred during the comparison period

Minimum = Smallest net difference that occurred during the comparison period

The intent of the Commitment of Traders Index is to rank the current spread between the commercial and speculative positions within the context of the historic range. There seems to be uniform agreement the commercials are the group that determines the direction of prices. A shift in the position of the commercials should be closely watched.

PutCall Ratios

The ratio of put option volume to call option volume, called the putcall ratio, is the major sentiment index for listed options. It too is used for its contrary value. The interpretation of extreme levels of the putcall ratios (in particular, the index option) points out a problem that may reflect on the proper use of all contrary indicators.

Prior to 1986, the market was considered ready for an upturn when the total put volume exceeded 65% of the total call volume. Similarly, when the put volume fell to 35% of the call volume it was a bearish indication. In the volatile markets of 1986 and 1987 these levels proved to be far too close, and as McMillan said, "Not surprisingly, the putcall ratios fell into some disfavor at that point." This could easily happen with a contrary indicator, or any indicator that rarely reaches its extreme values. Because contrary opinion is a valuable addition to analysis, use of these indicators now focuses on relative highs and lows. This can be accomplished by smoothing the ratio using a standard moving average or momentum indicator (a simple difference over ndays). When the ratio moves over 65% and turns down it is time to sell. Such an approach gives up a timing edge but greatly reduces risk and increases reliability

FIBONACCI AND HUMAN BEHAVIOR

Even though we may not understand the cause underlying a particular phenomenon, we can, by observation, predict the phenomenon's recurrence.

R.N. Elliott"

History is a record of great achievement in the face of disbelief as exhibited by the explorations of Columbus, Magellan, Marco Polo; the science of da Vinci, Galileo, Copernicus., and the philosophy of Socrates and other men now known to be great. We are more observant today and less apt to condemn those who delve into areas still unknown. Of these, astrology is the most popular, with a very large following, particularly in

Asia. Its acceptance may be partly because of its strong basis in physical phenomena. It attempts to classify personality and behavioral traits based on positions of planets and stars at the time of birth, and to predict the actions of groups based on the relationships of planets, moons, and comets to one another. The science of physics confirms that the positions of our moon and planets, the energy given off, and the gravitational phenomenon are directly responsible for physical occurrences of tides and weathershould they not have a measurable effect on behavior? This will be considered in the following sections.

17 Lawrence G. McMiNan, "PutCall Ratios," Technical Analysis of Stocks & Commodities (October 1995).

8 R.N. Elliott, *Nature's Law. The Secret of the Universe* (Elliott, New York, 1946 p. 4).

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Let us look first at the fascinating subject of symmetry in nature. Science is familiar with the symmetric shapes of crystalline substances, snowflakes, the spherical planets, and the human body. The periodicity of the universesun spots, eclipses, and other Cyclic phenomena is also understood, but its bearing on human behavior is not yet known. Work in biorhythms is only at the point of being a curiosity; the relationship of behavior to nonbiological functions, such as planetary positions, is too abstract.

In 1904, Arthur H. Church wrote about phyllotaxis, the leaf arrangement of plants,` showing its relationship to a mathematical series based on the works of Leonardo Pisano (Fibonacci).` This mathematical series of numbers has been attributed the quality of representing human behavior. Examples have been given that appear to be more than interesting coincidences."

It is not certain how Fibonacci conceived his summation series. His greatest work, *Liber Abaci*, written in the early part of the thirteenth century, was not published until 1857." It contained a description of a situation involving the reproduction of rabbits in which the following two conditions hold: Every month each pair produces a new pair, which, from the second month on become productive; deaths do not occur. This becomes the famous Fibonacci summation series

1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144....

(more currently written 1, 1, 2, 3, . . .). It can be easily seen that each element of the series is the sum of the two previous entries.

Those who have studied the life of Fibonacci often attribute the series to his observations of the Great Pyramid of Giza. This pyramid, dating from a preliterate, prehierarchical era, contains many features said to have been observed by Fibonacci. In the geometry of a pyramid there are 5 surfaces and 8 edges, for a total of 13 surfaces and edges; there are 3 edges visible from any one side. More specifically, the Great Pyramid of Giza is 5,813 inches high (5813, and the inch is the standard Egyptian unit of measure); and the ratio of the elevation to the base is .618. The coincidence of this ratio is that it is the same as the ratio that is approached by any two consecutive Fibonacci numbers; for example,

$$\frac{2}{3} = .667, \quad \frac{3}{5} = .600, \quad \frac{5}{8} = .625, \quad \dots, \quad \frac{89}{144} = .$$

it is also true that the ratio of one side to a diagonal of a regular pentagon is .618.

Another phenomenon of the pyramid is that the total of the 4 edges of the base, measured in inches, is 36,524.22, which is exactly 100 times the length of the solar year. This permits interpretations of the Fibonacci summation series to be applied to time.

The Greeks showed a great fascination for the ratios of the Fibonacci series, noting that while $F_j/F_n = .618$, the reverse $F_{n+1}/F_n = 1.618$ was even more amazing. They expressed these relationships as golden sections and appear to have used them in the proportions of such works as the Parthenon, the sculpture of Phidias, and classic vases. Leonardo da Vinci consciously employed the ratio in his art. It has always been a curiosity that the great mathematician, Pythagoras, left behind a symbol of a triangle of Fibonacci proportions with the words "The Secret of the Universe" inscribed below.

A.H. Church, *On the Relation of Phyllotaxis to Mechanical Laws* (Williams and Newgate, London, 1904).

In the appendices to Jay Hambridge, *Dynamic Symmetry: The Greek Vase* (Yale University Press, New Haven, CT, 1931, pp. 141-161), there is a full discussion of the evolution of this number series within science and mathematics, together with further references.

"Il Liber Abaci di Leonardo Pisano, (Baldassare Boncompagni, Rome, Italy, 1857).

22 Jay Hambridge, *Dynamic Symmetry, The Greek Vase* (Yale University Press, New Haven, CT, 1931, pp. 273-8).

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Church, in his work in phyllotaxis, studied the sunflower, noting that one of normal size (5 to 6 inches) has a total of 89 curves, 55 in one direction and 34 in another. In observing sunflowers of other sizes, he found that the total curves are Fibonacci numbers (up to 144) with the two previous numbers in the series describing the distribution of curves. The chambered nautilus is considered a natural representation of a golden spiral, based on the proportions of the Fibonacci ratio (see Figure 147) in which the logarithmic spiral passes diagonally through opposite corners of successive squares, such as DE, EG, GJ, and so forth. Nature also shows that the genealogical pattern of a beehive, and the stem (growth) structure of the Sneezewort (*Achillea ptarmica*) are perfect duplicates of the Fibonacci series.

Up to now, aspects of the Fibonacci series have been intriguing, but here it goes a step beyond. The numbers in the series represent frequent or coincidental occurrences:

The human body has five major projections; both arms and legs have three sections; there are five fingers and toes, each with three sections (except the thumb and great toe). There are also five senses.

In music an octave means eight, with 8 white keys and 5 black, totaling 13.

There are three primary colors.

The United States had 13 original states and 13 is an unlucky number.

The legal age is 21 and the highest salute in the army is a 21 gun salute.

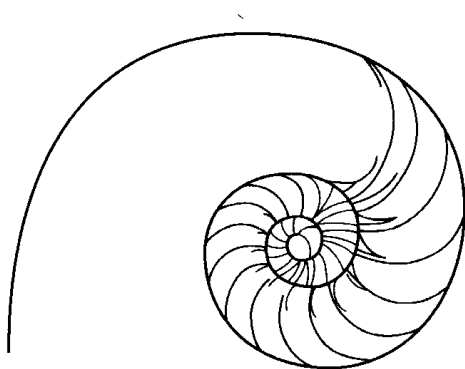
The human emotional cycle has been determined at 33 to 36 days by Dr. R.B. Heresy."

The wholesale price index of all commodities is shown to have peaks of 50 to 55 years according to the Kondratieff wave: 18 15 after the war of 18 12, 1865 after the Civil War, 1920 after the World War I, and about 1975...`

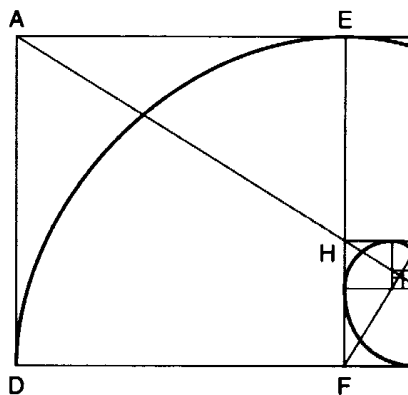
23 R.N. Elliott, *Nature's Law* (p. 55). Elliott quotes other human emotional relationships.

21 *Cycles* (January 1976, p. 2 1); see also *The Kondratieff Wave.. The Future of America Until 1981* and *Be~* (Dell, New York, 1974), which is based on the theory developed by the Russian economist early in this century.

FIGURE 147 The golden spiral, also the logarithmic spiral, is a perfect representation of the chambered nautilus.



Chambered nautilus



Logarithmic, or "golden" spi

Source: Robert Fischer, *Fibonacci Applications and Strategies for Traders* (John Wiley & Sons, 1993, p. 9). Original source: H.E. Huntley, *The Divine Proportion* (Dover, New York, 1970, pp. iv, 10 1). Reprinted with permission.

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These examples are not meant to prove anything in the strict sense, but to open an area that may not have previously been considered. Human behavior is not yet a pure science and probes of this sort may lead the way to further understanding. The following sections deal with ideas such as thesesometimes reasonable and other times seeming to stretch the imagination.

ELLIOTT'S WAVE PRINCIPLE

R.N. Elliott was responsible for one of the more highly regarded and complex forms of market technical analysis. The Elliott Wave Theory is a sophisticated method of price motion analysis and has received careful study by A.H. Bolton (1960), and later by Charles Collins. His works are fully covered in two more recent publications by Robert Prechter; brief summaries of the analysis appear in some of the comprehensive books on market analysis.` This presentation of Elliott's technique will include both the original principles and extensions with examples.

The Wave Theory is an analysis of behavioral patterns based on mathematics and implemented using price charts; its original application

was stocks and it is credited with predictive ability with respect to the Dow Jones Industrial Averages, which is second only to the occurrence of Haley's comet. It is understood that Elliott never intended to apply his principle to individual stocks, perhaps because the relatively low activity might distort those patterns that would have appeared as the result of mass behavior. If so, caution must be exercised when applying this method to individual stocks and futures markets.

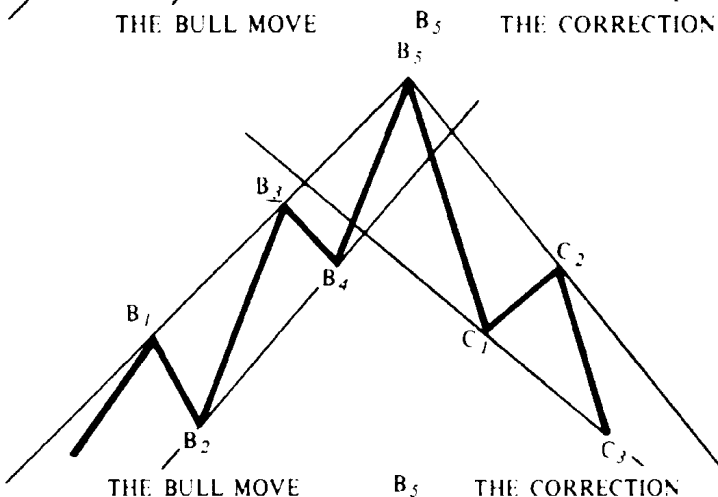
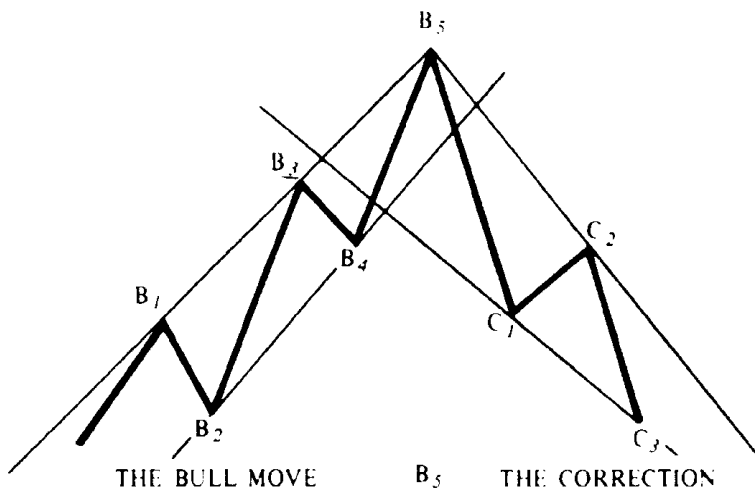
The successes of the Elliott Wave Theory are fascinating and serve to reinforce the use of the technique; most summaries of Elliott's work recount them and the reader is encouraged to read these. The waves referred to in the theory are price peaks and valleys, not the formal oscillations of sound waves or harmonics described in the science of physics. The waves of price motion are overreactions to both supply and demand factors within major bull moves developed in five waves and corrected in three. His broad concept was related to tidal wave bull markets that have such large upward thrusts that each wave could be divided into five subwaves satisfying the same principle. After each primary wave of the major bull trend there was a major corrective move of three waves, which could be further divided into subwaves of three (see Figure 148).

The types of waves could be classified into the broad categories of triangles and ABCs, representing a main trend and a correction, respectively. The term triangle was taken from the consolidating or broadening shape that the waves form within trendlines, although in later works Elliott eliminated the expanding form of the triangle (see Figure 149).

An interesting aspect of the theory is its compound complex nature, by which each sequence of triangles can occur in subwaves within waves (Figure 1410). More recent work suggests that in futures markets, a three-wave development is more common than five waves. Prechter, a well-known interpreter of Elliott's principles, has shown many major stock index moves that conform to the ratio of 1.618. The stock index, which has great participation, is most likely to represent the generalized patterns of human behavior.

" Robert R. Prechter, Jr., *The Major Works of R.N. Elliott* (New Classics Library Chappaqua, NY (circa. 1980)); and A.J. Frost and Robert R. Prechter, Jr., *Elliott Wave Principle* (New Classics Library Chappaqua, NY, 1978); Merrill (1960) Appendices 5 and 6 contain one of the more thorough summaries and analyses of the basic Wave Theory, including performance.

Robert R. Prechter, Jr., David Weiss, and David Allman, "Forecasting Prices with the Elliott Wave Principle," in *Trading Tactics.. A Livestock Futures Anthology*, Todd Lofton (ed.) (Chicago Mercantile Exchange, 1986).



Elliott's Sideways Markets

Occasionally, the market pauses during a major move, or it may move sideways in a volatile pattern after completing the fifth leg of a wave. This has been described as stock prices seen to be waiting for economic fundamentals to catch up with the market expectations. These periods can be represented by a single three, a simple zigzag or flat formation, or by the more extended double or triple three (Figure 1411).

A small variation of the single three has been noted to occur following the third wave, when the zigzag forms a minor swing reversal with b lower than its preceding top, and c lower than a. Elliott has also recognized this as a descending zigzag in an upward trend.

Fitting the Market to the Patterns

One point to remember when applying an intricate set of rules is that an exact fit will not occur often. The best trading opportunities that will arise will be for those price patterns that fit best as the move is progressing; each successful step will serve as positive rein

See Robert R. Prechter. Forecasting Prices (1986),
Robert R. Pretcher, r.. Computerizing Elliot. "Technical Analysis of Stocks & Commodities)July 1983), gives sonic general observations on how he would go about adapting Elliott's interpretations to a computer program.

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FIGURE 149 Triangles and ABCs.

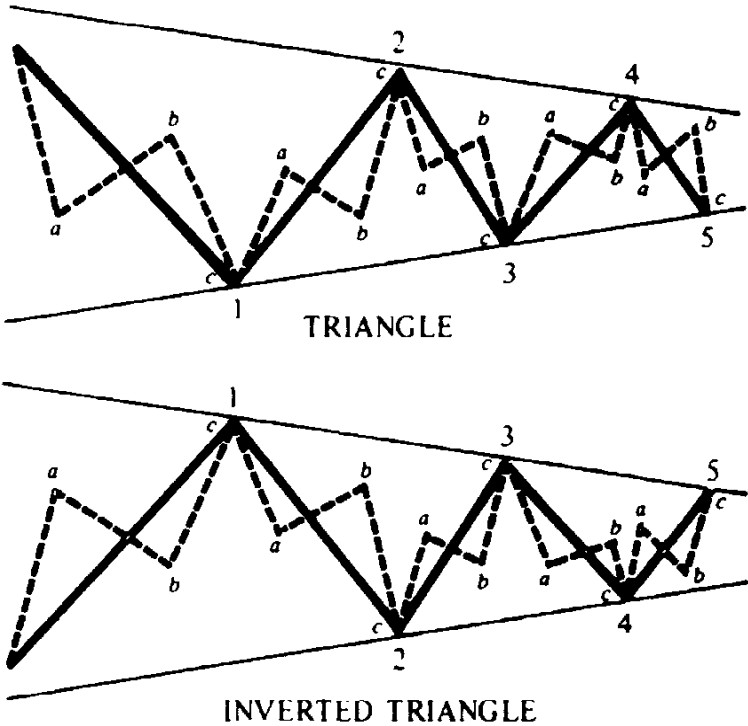


FIGURE 14 10 Compound correction waves.

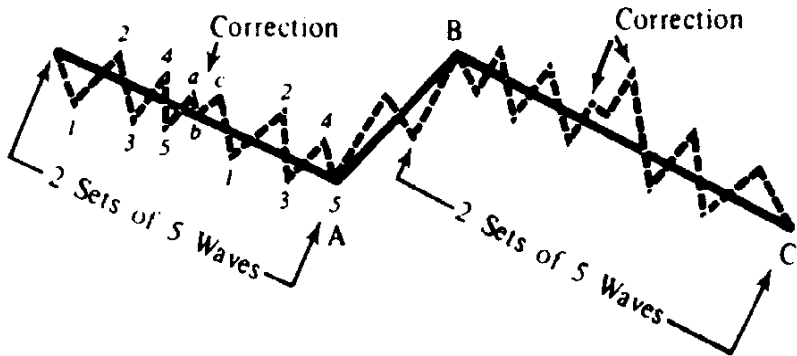
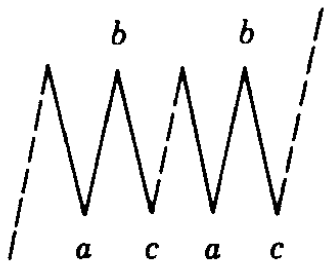


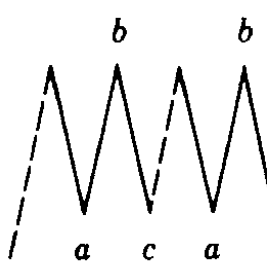
FIGURE 1411 Elliott's threes.



Single



Double



Triple

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forcement for continuing. The critical period in the identification process is the fifth wave. The failure of the fifth wave to form indicates that the last correction of three waves will be retraced. in a bull market, an extension of the fifth wave is often followed by a corrective threewave function. in addition, the recognition of a fivewave sequence should be followed by further analysis to determine whether that cycle was part of a more complex series. One of the difficulties in the method is the orientation of the current position to the wave formation; the multitude of primary and secondary waves makes some of the situations subjective until further developments clarify the position. Anyone interested in the further complexities of wave formation should refer directly to Bolton's work.

Elliott's Use of the Fibonacci Series

The application of the Elliott Wave Theory was unique in its use of the Fibonacci series. Besides the natural phenomena mentioned earlier, the summation series has the mathematical properties that

The ratio of any number to its successor (E_i/F_{i+1}) ap

The ratio of any number to its previous element (F_i

The ratio of F_{i+2}/F_i is 2.618.

The two ratios $(F_i/F_{i+1}) \times (F_{i+1}/F_i) = .618 \times 1.618 = 1$

Elliott was also able to link certain measurements of the Great Pyramid to the Fibonacci series and connect the number of days in the year as well as the geometric figure of a circle to his theory Both time and the circle will play a role in Elliott wave analysis.

While Elliott used the lower end of the Fibonacci series to describe the patterns in the stock market, it should be noted that there are increasingly larger gaps between successive entries as the series increases. To be consistent with the original principle, each gap could be subdivided into another Fibonacci series in the same manner that the waves take on a complex formation. Harahus offers an alternate approach to filling these spaces by use of Lucas numbers, formed in the same way as the Fibonacci

summation beginning with (1, 3) and resulting in (1, 3, 4, 7, 11, 18, 29, 47, 76, 123, 199). The two sets are combined, eliminating common numbers, to form (1, 2, 3, 4, 5, 7, 8, 13, 18, 21, 29, 34, 47, 55, 76, 89, 123, 144, 199, 233, ...). The Fibonacci numbers have been italicized since they will receive the most emphasis, whereas the Lucas numbers will serve as intermediate levels of less significance. The numbers themselves are applied to predict the length in days of a price move. A bull move that lasts for more than 34 days should meet major resistance or reverse on the 55th day or on the 89th day (considering Fibonacci numbers only). It is suggested that a penetration of the 89th day should permit the series to start again with the beginning of the series added to 89 (e.g 94, 96, 97, 102, 107, 110, 118, 123, 136 ...), including the more important Lucas and Fibonacci numbers from the original series. This effect is similar to the complex wavewithinawave motion.

The same numbers are used to express key levels in a trend reversal. For example, a bull move that carries prices up for about 47 days before a reversal should meet resistance at the price level on the 34th day. If that price does not stop the reversal, either the behavioral implications of the number series do not hold for this situation or prices are in a different part of the cycle.

With the introduction of Lucas numbers (L), the combined Fibonacci-Lucas series (FL), denote any of the other series following entry i ; L_j is the first Fibonacci number. This results in the ratios $F_i/L_j =$

The important ratio of a Fibonacci number to the ratio of successive numbers ($1/2, 2/3, 3/5, 5/8,$

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in decimal, these ratios approach the number .618 in a convergent oscillating series (1.000, .500, .667, .625, .615, .619, ...). These ratios, the key Fibonacci/Lucas ratios, and the alternate entry ratios, represent the potential resistance levels (in terms of percentage) for price adjustments within a well-defined move. For example, a price advance of \$ 1.00 in silver to \$5.00 might correct 100%, 50%, or 62%, to \$4.00, \$4.50, or \$4.38, respectively, according to the most important ratios.

Trading Elliott

Elliott also knew that there was great variability in this adherence to waves and ratios. The appearance of the waves is not regular in either length or duration and should not be expected to continually increase as they develop, although the fifth wave is generally the longest. The waves must be identified by peaks only. Elliott introduced a channel into his

theory to determine the direction of the wave being analyzed as well as to establish intermediate price objectives. Looking back at the diagram of the basic wave, note the channel drawn touching the peaks and bottoms of the bull move. For every two peaks, a channel can be drawn that will serve as a trendline for price objectives. This same technique is covered in detail in a later section of Chapter 12. A break of the lower trendline in the bull move will serve to tell when a correction has begun.

The Elliott Wave Theory is very intricate and should not be attempted without careful study of the original material, but some rules are presented here to help understand the nature of the method:

1. Identify a main trend.
2. Determine the current status of the main trend by locating the major peaks and bottoms that will form the five key waves.
3. Look for three wave corrections and five wave subrends or extensions.
4. Draw trendlines to determine the direction.
5. Measure the length of the waves in days to determine its adherence to the FibonacciLucas sequence. measure the size of reactions as compared with FL ratios.
6. Watch for reactions at points predicted by the FL sequence and corresponding to the patterns described by the fivewave main trend and threewave correction.
7. Use the ratios, day counts, and trendlines as predictive devices to select price objectives.
8. Use the trendlines to determine changes of direction.

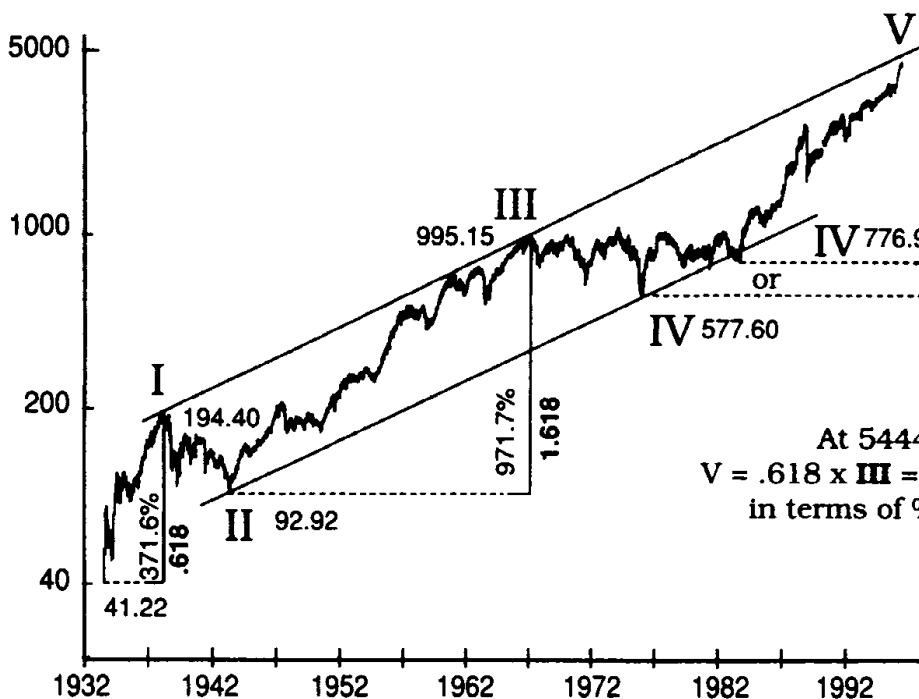
As can be seen below, much of this systematic identification of waves has been done using a computer.

The Supercycle

When the shortterm patterns fail to fit the rules, the bigger formations are likely to work. This approach applies to all chart analysis, and Elliott's wave theory is not an exception. Shorter time periods include relatively more noise, which may be difficult to separate from the significant market movement. Robert Prechter, well known for his focus on Elliott, uses a supercycle to describe the fifth wave of the prolonged bull move, which is still intact in 1997 (see Figure 1412), applying Fibonacci ratios to forecast targets and explain the past moves.'

When using a charting technique, it is best to look for markets that, in some time frame, conform to the type of patterns you are seeking. This is also true with Elliott, which requires that prices advance in proportion to the Fibonacci ratios. In the DJIA supercycle, shown in Figure 1412,

⁹ Robert R. Prechter, Jr., "Major sea change II," *Futures* (March 1996).



This chart includes the 1982 "orthodox" end-of-pattern low.

Source.. Robert Prechter, jr., Futures (March 1996). Copyrighted 1996 by Robert Prechter,jr. Reprinted with permission of Futures.

1. Wave 1 begins at the 1932 low of 41.22, peaking in 1937 at the high of 194.40, a gain of 371.61%.
2. A wave 2 retracement follows.
3. Wave 3 starts in 1942 at the low of 92.29 and ends in 1966 at the high of 995.15, a gain of 970.975%. Note that when you divide the first gain by the second gain, $371.616/970.975$, you get the classic Fibonacci ratio .3827.
4. The fifth wave should then follow the same pattern, and gain 600.692%. This target is found by solving for the value of wave 5, where $\text{wave I}/\text{wave 5} = \text{wave 5}/\text{wave 3} = .618$

This gain of 600% is based on the low of 776.92, and gives a target price of 5,444. Traders are cautioned that the high volatility and unusual extension of the current move is likely to cause very specific targets, such as this, to be violated by as much as 10%.

Automating Elliott's Wave Analysis

While analysts believe that there is substantial value in Elliott's method, it has been considered too subjective and cannot be evaluated with the rigorous historic testing that has become popular. Recent years, however, have shown that a talented analyst and much more computer power can combine to produce programs that can come close to a true

version of what was once the exclusive domain of human interpretation. Elliott's wave theory has not been immune to this technology. 30

The content of this section is based on Murray A. Ruggiero, Jr., "Building the wave," Futures (April 1996). He credits Tom Joseph for the development of the computer software, which is the basis for the product, Advanced GET

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Murray Ruggiero has defined the trading opportunities for a basic Elliott wave pattern to be:

1. Enter wave 3 in the direction of the trend.
2. Stay out of the market during wave 4 (a retracement).
3. Enter wave 5 in the direction of the trend.
4. Take the countertrend trade at the top of wave 5.

When a wave appears in two time frames, such as both daily and weekly charts, the likelihood of the success of this formation increases. This concept is well accepted throughout technical analysis and can be found in many sections of this book, including Chapter 19 ("Multiple Time Frames"). Without confirmation of a pattern or trade, the risk increases.

The key to automating Elliott's technique is the creation of the Elliott wave oscillator (EWO). A series of extensions and pullbacks can be found using the EWO, combined with a method of counting waves that locates the current price within the standard Elliott wave pattern. The following steps present the bull move only, although the downside is treated as just the reverse set of rules.

1. Calculate the Elliott wave oscillator (EWO) as the difference between a 5period and a 35period simple moving average, applied to the average of the high and low prices,

$$\text{mean} = (\text{high} + \text{low}) / 2$$

$$\text{EWO} = @average(\text{mean}, 5) -$$

2. A new upward trend begins when the EWO makes a new high for 'a period, n, determined by the user. This allows, for example, wave 3 to be identified when it goes above the high of wave 1.
3. A new upward trend also begins when the current value of EWO is below zero (the 5day average is below the 35day average), and the trend is down (Step 2), but the EWO has rallied by a percentage (called the trigger) of the lowest oscillator value of the past n periods (@1 owes t (EWO, n)). Then the trend is up if EWO is below zero, the previous trend value is down, and

$$\text{EWO} > \text{trigger} * @lowest(\text{EWO}$$

This rule allows the next wave to be found based on the retracement that comes between each wave.

4. To relate this to Elliott, we must know where prices are located in the five-wave sequence. For an uptrend, this is done in the following order:
 - a. When the trend turns from down to up we assume it is the beginning of wave 3 and save the current values of EWO and price.
 - b. Continue to save the new high EWO value and new high price for wave 3.
 - c. Wave 4 begins when EWO falls to zero.
 - d. If wave 4 is currently active and the price is a 5-period high and $EWO > 0$, then wave 5 begins. Save the highest EWO value and highest price of wave 5 whenever they occur.
 - e. If EWO in wave 5 becomes higher than the highest EWO value in wave 3, then we are still in wave 3. Label the current wave 5 values to indicate wave 3, and continue as in wave 3 with step b.
 - f. If the trend turns from up to down in wave 5, then this is a wave 3 down. Reset all values and look for a new wave 3 up when step a is satisfied.

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- 5 The trading rules needed are based on the values of n , the number of periods, and the trigger (the percentage retracement).

Buy on open when wave 3 is first identified, whether on a new n -period high or a retracement of the previous

downturn (step a).

- b. Buy on the open when wave 5 is first identified (step d)
- c. Buy on the open when wave 5 turns into wave 3 (step c).
- d. Close out any long position when EWO falls below zero.

With these rules, a long position is taken during the strongest parts of wave 3 and wave 5. As a guideline for selecting both the period and the trigger values, a test of the Deutschmark for 20 years from 1976 through 1995 showed robust results for periods n from 50 to 140 and for retracement trigger values of .70 or less.

```

{FUNCTION EWO}
{Find the Elliott Wave Oscillator (EWO)}
vars: mean(0);
mean = (high + low) / 2;
EWO = 0;
if @average(mean,35) <> 0 then EWO = @average(mean,5)
{FUNCTION EWTREND}
{Find the trend using EWO}
inputs: period(numeric), trigger(numeric);
vars: trend(0), osc(0);

osc = EWO;
if osc = @highest(osc,period) and trend = 0 then trend
if osc = @lowest(osc, period) and trend = 0 then trend
if @lowest(osc,period) < 0 and trend = -1 and
    osc > -1*trigger*@lowest(osc,period) then tren
if @highest(osc,period) > 0 and trend = 1 and
    osc < -1*trigger*@highest(osc,period) then tre
EWTREND = trend;
{FUNCTION ELLIOTTWAVE}
{Find the current wave using EWTREND and EWO}
inputs: period(numeric), trigger(numeric)
vars: ET(0), mean(0), osc(0), wave(0), hiosc(-999), hi
    hiprice2(-999);
osc = EWO;
mean = (high + low)/2;
{Is the current wave sequence up or down?}
ET = EWTREND(period,trigger);
{When the trend changes from down to up, label it wave
and price}
if ET = 1 and ET[1] = -1 and osc > 0 then begin
    hiosc = osc;
    hiprice = mean;
    wave = 3;
end;
{If wave 3 and the oscillator make new highs then save
if wave = 3 then begin
    if mean > hiprice then hiprice = mean;
    if osc > hiosc then hiosc = osc;
{Test for the beginning of wave 4}
    if osc <= 0 and ET = 1 then wave = 4;
end;
{Test for the beginning of wave 5}
if wave = 4 and mean = @highest(mean,5) and osc >= 0 th
    wave = 5;
    hiosc2 = osc;

```

```

        hiprice2 = mean;
        end;
if wave = 5 then begin
    if osc > hiosc2 then hiosc2 =
        if mean > hiprice2 then hipr
        end;
{Test for wave 5 becoming wave 3}
if wave = 5 and hiosc2 > hiosc and E
    wave = 3;
    hiosc = hiosc2;
    hiprice = hiprice2;
    hiosc2 = -999;
    hiprice2 = -999;
    end;
{Identify a wave 3 down while in wav
if wave = 5 and ET = -1 then begin
    wave = 3;
    hiosc = -999;
    hiprice = -999;
    hiosc2 = -999;
    hiprice2 = -999;
    end;
{Return function value}
EWO = wave;

```

CONSTRUCTIONS USING THE FIBONACCI RATIO

Harahus shows interesting constructions using Fibonacci ratios;

these are referred to as the golden rectangle, golden triangle, and golden spiral. Although there is no doubt of their importance, the application to markets can be complicated. As a behavioral model, any technique is subject to gross inaccuracy at times. In using a method as sophisticated as the Elliott Wave Theory, it is necessary to select situations that are representative examples of the phenomenon described by the FL sequence. Confirmation of such action can only be found by careful monitoring and development of an awareness of the nature of the price motion important to the system.

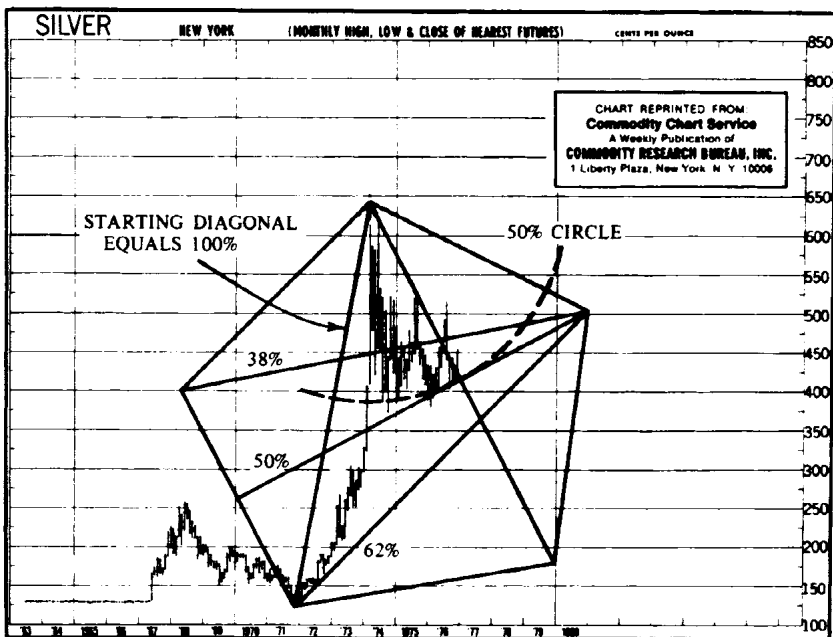
Harahus further introduced the regular pentagon as a tool for measuring corrections. This geometric figure has the property that any diagonal is 1.618 times the length of a side, exactly a Fibonacci ratio.

By constructing a regular pentagon so that the major trend falls along one diagonal (or one side), the other line connecting the corners of the pentagon will serve as support or resistance to price moves. In addition, the circumscribed and inscribed circle will serve as a measurement of support and/or resistance (Figure 1413).

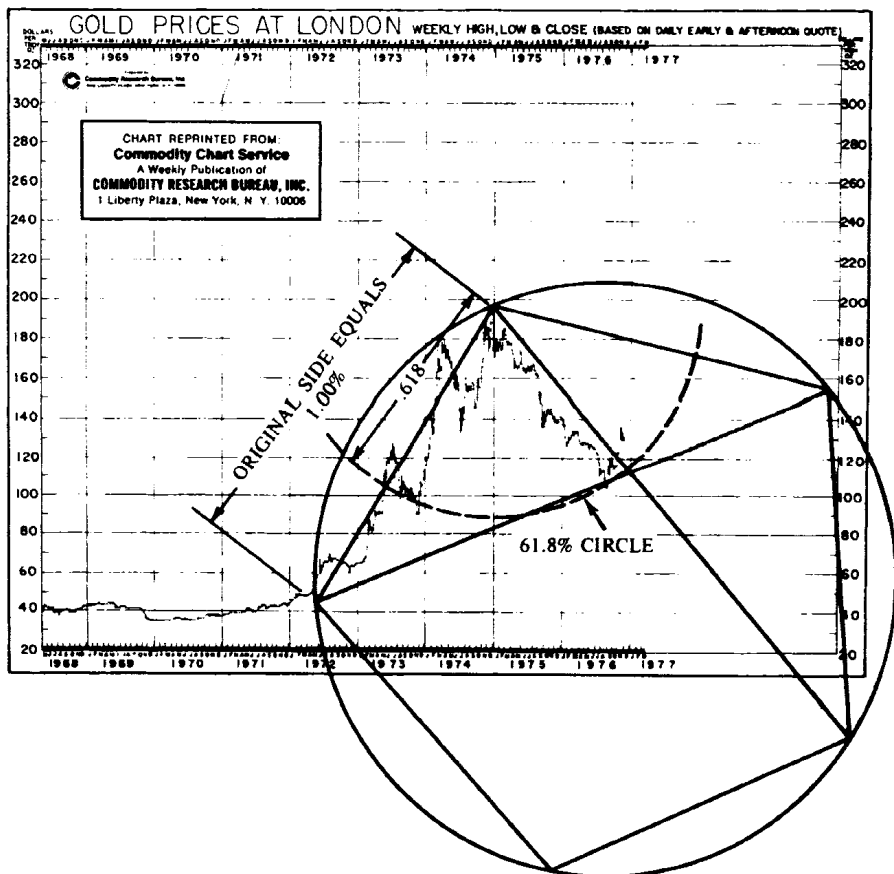
Harahus further extends the charting techniques of the Elliott Wave Theory using circles and arcs, a technique previously seen in measuring retracements. A circle drawn from the top or bottom of a wave, representing the 38%, 50%, or 62% levels serves as a convenient measurement of either elapsed time or a price adjustment, either of which could occur within the bounds of the rules. Prices are expected to meet resistance at any attempt to penetrate the key circles formed about either A or B in Figure 1414.

The Elliott Wave Theory is highly regarded, although it is an odd combination of mathematics and chart interpretation bordering slightly on the mystic. Because it is primarily based on chart patterns it has been criticized as being too interpretive. The development of the fifth wave receives the most commentsometimes it never develops; at other times, it must be extended into another subset of waves. In an analysis by Merrill, it is shown that the median stock market bull move has seven legs and the bear move has five legs; this may account for the need for the compound form of the Elliott wave. Those analysts who find

FIGURE 1413 (a) Pentagon constructed from one diagonal. (b) Pentagon constructed from one side.



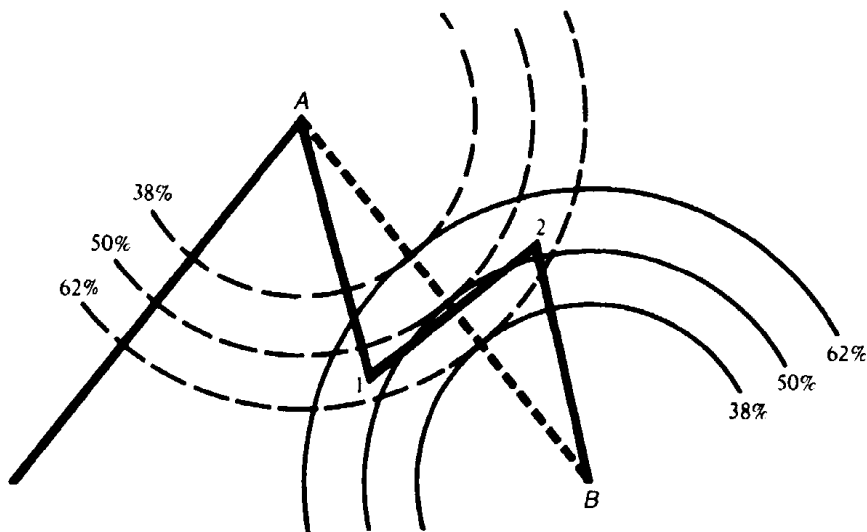
(a)



(b)

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FIGURE 1414 Using circles to find support and resistance.



this study of interest should also read the works of WD. Gann and Edson Gould, both of whom concentrated on mathematical approaches to charting.

Alternate Arc Measurement

In Chapter 12 ("Charting Systems"), it was noted that, for the purposes of finding retracement levels, Tom DeMark identified the extent of a price move differently. In his approach, if the market is currently at a low, rather than judging the distance of this drop from the most recent swing high, he chooses to look for the highest point that has occurred since the last time the market traded at this low level. He then applies his choice of ratios to isolate key retracement levels. DeMark also uses this measurement from high to low to draw arcs identical to those shown in Figure 148 but limited to the Fibonacci ratio .618 and its complement .382.

FISCHER'S GOLDEN SECTION COMPASS SYSTEM

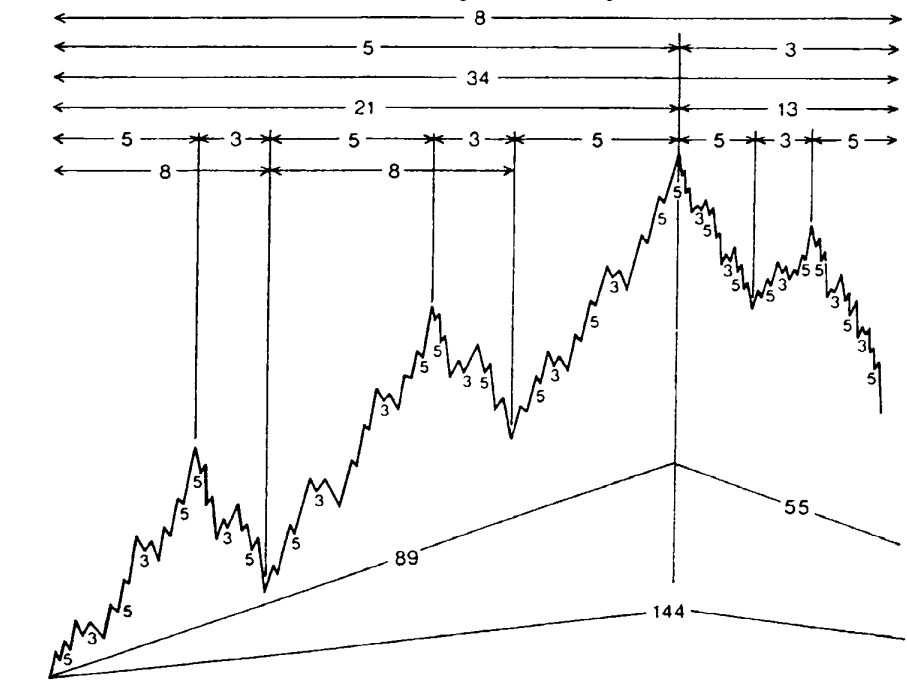
Although there are many systems that use the Fibonacci ratios, Fischer's Golden Section Compass (GSC) System is the only one based primarily on that concept.³¹ The system is founded on the premise that human behavior reflects the Fibonacci ratios; the human decisionmaking process unconsciously selects points to act that appear to be the right time or the right price level. The behaviorbased rules are combined with practical entry and stoploss rules to eliminate those situations that do not properly develop.

Fischer is not alone in his observation of these patterns. Elliott, discussed in the previous sections, defined market cycles in five wave patterns with three wave corrections (Figure 1415). In *Nature's Law*, Elliott shows the complete market cycle 13 as:

"Tom DeMark, "Retracing your steps," *Futures* (November 1995). Also see Chapter 2 of DeMark, *The New science of Technical Analysis* (John Wiley & Sons, 1994).

³¹ Robert Fischer, *The Golden Section Compass Seminar* (Fibonacci Trading, Ltd., Hamilton 5, Bermuda, 1984). Also see Robert Fischer, *Fibonacci Applications and Strategies for Traders* (John Wiley & Sons, 1993).

FIGURE 1415 Elliott's complete wave cycle.



Source: Fischer, *Golden Section Compass Seminar* (1984, p. 28).

Number of	Bull Market	Bear Market	Total
Major waves	5	3	8 complete cycles
Intermediate waves	21	13	34 complete cycles
Minor waves	89	55	144 complete cycles

Time-Goal Days

The GSC System states that a new price direction will begin on, or shortly after, the time goal is calculated as:

$$T_k = 1.618 \times (L_t - L_{t-1}) + L_t$$

or

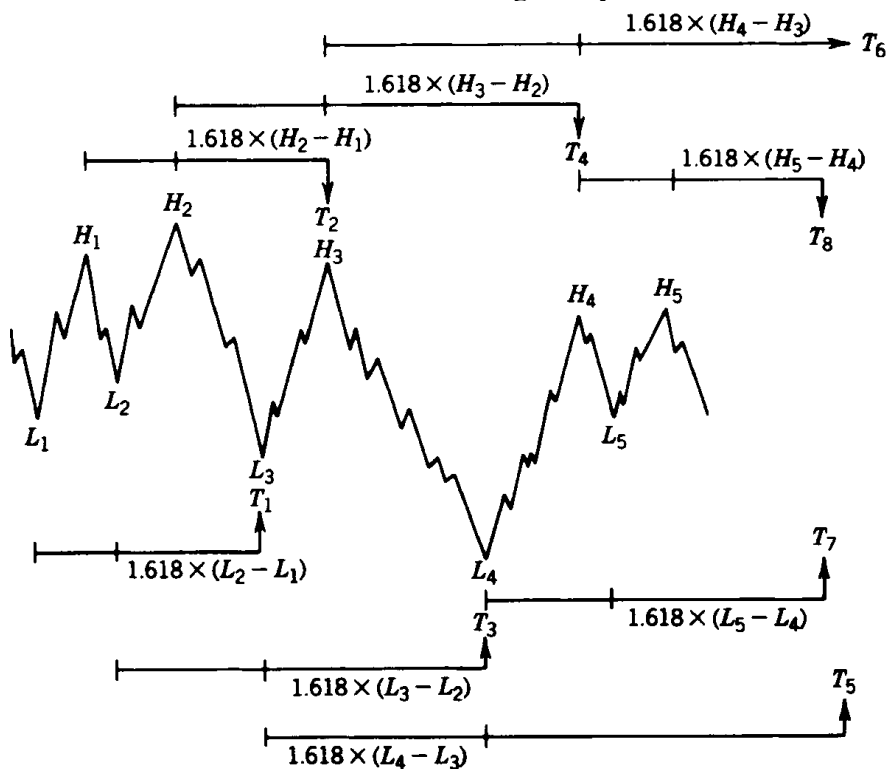
$$T_{k+1} = 1.618 \times (H_t - H_{t-1}) + H_t$$

where L_i and H_i are the days on which lows and highs occur

For simplicity, an extreme may be used only twice—on the first and the second. Figure 14-16 shows the order in which the calculation was calculated from lows L_3 and L_4 before time-goal day T_7 time-goal day occurs at the same point, or when the high goal days are more significant, the likelihood of a major re

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FIGURE 1416 Calculation of timegoal days.



Specific entry signals occur on a 5day price reversal. A long signal is given following a timegoal day when the closing price is higher than the high of the past 5 days. This is sufficient to identify a trend change and allows the stoploss to be the recent low or a fixed point below the entry point.

Price Goals

Price objectives are determined using the same highs and lows. Elliott's wave theory is refined by Fischer, as shown in Figure 1417. Once the low has been found, followed by wave 1, the price objectives for waves

3 and 5 can be calculated as a function of wave 1:

Wave 3 objective = $.618 \times (\text{wave 1 low}) + \text{low}$

Wave 5 objective = $1.618 \times (\text{wave 1 low}) + \text{low}$

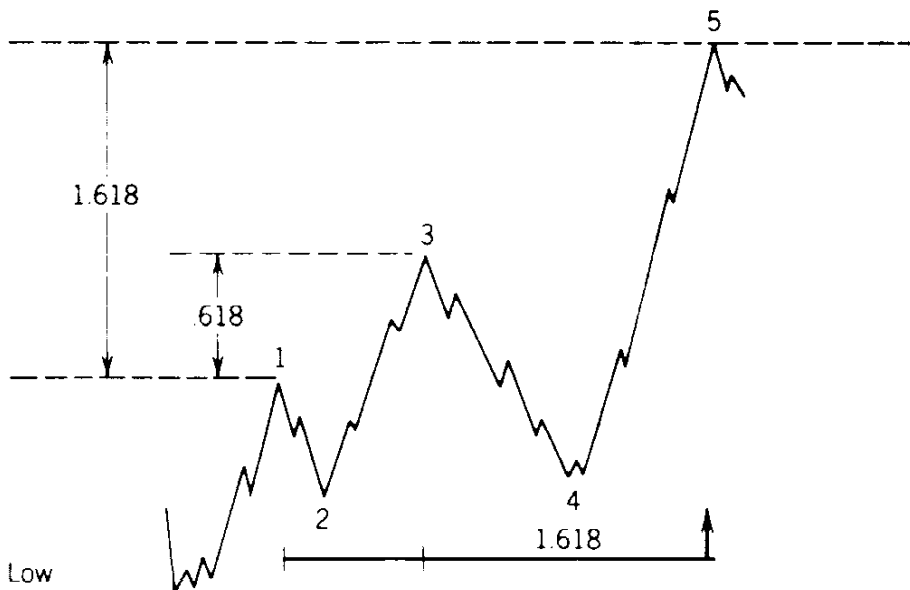
The pullbacks to points 2 and 4 are not determined in this calculation, and the probability of the five-wave formation occurring is not confirmed unless the wave 3 objective is satisfied. Price goals are used for profit-taking rather than new entry points. The GSC System, however, does not require that markets move in five-wave patterns. Price objectives can be calculated from long-term lows as $1.618 \times \text{initial move up}$. When price and time goals occur at the same point, there is greater reliance on the signal.'

In general, retracements from sustained moves can be expected to approximate or exceed 38.2% ($1/1.618$) of the initial move. Once a high-level objective has been reached and a reversal occurs, consistent profits may be taken using this goal. If prices fail to make

34 Examples of time and price objectives can be found in Tucker J. Emmett, *Fibonacci Cycles*, "Technical Analysis of Stocks & Commodities (May 1983 and March/April 1984).

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FIGURE 1417 Price goals for standard five-wave moves.



new highs following the first retracement, objectives for the next lower levels down can be set according to the inverted Elliott wave patterns, or $1/1.618 \times \text{initial downward move}$.

Filtering Highs and Lows

The GSC System can be made to identify with more significant highs and lows by increasing the selection filter. For example, a sensitive system would select highs and lows in gold that are separated by a minimum swing of \$10 per ounce. More significant points may be identified by swings of \$20 per ounce. It can be demonstrated that a small

filter will generate highs and lows that are produced by noise rather than significant behavioral actions. The system cannot be forced to produce more signals than the natural patterns allow.

The selection filter should be adjusted for market volatility. At higher price levels the noise also increases and will obscure the more important high and low points. Although Fischer only briefly touches on this, traders who apply this method should be prepared to adjust the selection filter from time to time.

WD. GANN TIME AND SPACE

The works of WD. Gann cannot be explained with any thoroughness in a few words, but some of his main ideas have been selected and presented in this section. Gann was a pure technician using charts for all his analyses. His methods varied substantially from conventional charting techniques, but his philosophy was one of a professional trader: Conserve Your capital and wait for the right time Gann traded primarily grains for many years, and in his writings he attempted to summarize his most important observations: some of them are reminiscent of other wellknown market lore.

Price moves are never exact. Gann was a believer in support and resistance lines, but expected some violation of the objectives because of lost motion his way of accounting for the momentum that carries prices higher or lower than their likely goals. Nearly a cross between Elliott's waves and Angas's cycles, Gann classifies bull and bear moves into four stages, each one compared with a trending move and a subsequent reversal culminating in a major top or bottom. He observed that bull markets last longer than bear markets. He concluded that reversal patterns must reduce in magnitude as the move develops and persists. A similar argument is expressed in the theory, of contrary thinking. Much of Gann's work is related in 1940 cents and requires an economic inflator close at hand to adjust prices to today's levels.

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Gann's techniques combine mathematics and geometry with time and space; he finds duration as important as the size of the price change. One of his principles reflects the idea of a longer consolidation period resulting in a longer price move after a breakout. One popular approach to price objectives in bar charting is exactly this idea.

Time and Price

Gann proposed certain natural divisions for price swings expressed as percents. Zero and 100% are the most important of these. Based on behavioral awareness, he considered a potential resistance level at 100% of the original point of the move or 100% of the highest or lowest (the best guide) price of that market. In a reversal, 100% was a full retracement of the original move. The rationale for this theory is behavioral, as is his conclusion that most traders like even numbers; for this reason orders in grains are most often placed at 5 and 100 levels. Even now, traders will find more activity as prices attempt to cross whole number barriers, such as each 100 for the S&P, or each 1,000 for the DOW.

After the 100% level, decreased importance goes to increments of 50%, 25%, 12 1/2%, and so on. For a grain, this would mean that major resistance could be expected at the even dollar levels with the next

resistance at 500 intervals, then every 25 c, and so on; after a bull move of \$1, the major support would be \$1 lower, then 50c, 250 and 75c, and so on. The use of successive halving of intervals was also extended to time. A year is a full cycle of 360dg which makes onehalf of a year equal to 26 weeks, onequarter of a year 13 weeks, oneeighth of a year 45 days, and onesixteenth of a year 22Y2 days. in cases of conflict. time always took precedence over price. The combination of a key price level (percentage move) occurring at a periodic time interval is the basis for much of Gann's work.

Geometric Angles

The most popular of Gann's methods is his use of geometric angles for relating price and time. By using square graph paper, it was not necessary to know the exact angle because the construction was based on the number of boxes up versus the number of boxes to the right. A 1 x 1 angle (45') was drawn diagonally from the bottom of the lowest point of a price move through the intersection 1 box up and 1 box to the right. This is the primary bullish support line. A bearish resistance line is drawn down from left to right from the highest price using the 1 x 1 angle. The next most important angles in order of significance are 2 x 1, 4 x 1, and 8 x 1; for lower support areas there is also 1 x 2, 1 x 4, and 1 x 8. Places where the support and resistance lines cross are of special significance, indicating a major congestion area.

Figure 1418 is taken from Gann's private papers and shows the use of geometric angles in an actual trading situation. Lines were first drawn where Gann expected a bottom, then redrawn. The initial upward move followed the primary 45' line; the second important support line, 1 x 2, met the primary downward line at the point of wide congestion at the center of the chart. The highest point on this congestion phase became the pivot point for the next 45' downward angle defining the next breakout. Traders have found the primary 1 X 1, or 45' line, an important tool for staying with the major trend. It is used to filter out small reversals in both standard charting techniques and pointand figure.

Gann combined this method with a more remarkable technique, the squaring of price and time. It was fortunate to find a chart that complemented Figure 1418, based on the lowest recorded cash price of soybeans, 440 per bushel. Figure 1419 shows how Gann constructed this square, beginning with the lowest price at the center and moving one square to the right, circling counterclockwise and continuing the process. The basic geometric lines (horizontal, vertical, and diagonal) indicate the major support and resistance price levels; the most important one being 44, the junction of all lines.

MAY SOY BEAN RESISTANCE AND SUPPORT

441	443	442	441	440	439	438	437	436	435	434	433	432	431	430
368	367	366	365	364	363	362	361	360	359	358	357	356	355	354
369	300	299	298	297	296	295	294	293	292	291	290	289	288	287
370	301	240	239	238	237	236	235	234	233	232	231	230	229	228
371	302	241	188	187	186	185	184	183	182	181	180	179	178	177
372	303	242	189	144	143	142	141	140	139	138	137	136	135	134
373	304	243	190	145	108	107	106	105	104	103	102	101	100	99
374	305	244	191	146	109	80	79	78	77	76	75	74	73	72
375	306	245	192	147	110	81	60	59	58	57	56	55	54	53
376	307	246	193	148	111	82	61	48	47	46	45	44	43	42
377	308	247	194	149	112	83	62	49	48	47	46	45	44	43
378	309	248	195	150	113	84	63	50	51	52	53	54	55	56
379	310	249	196	151	114	85	64	65	66	67	68	69	70	71
380	311	250	197	152	115	86	87	88	89	90	91	92	93	94
381	310	251	198	153	116	117	118	119	120	121	122	123	124	125
382	313	252	199	154	155	156	157	158	159	160	161	162	163	164
383	314	253	200	201	202	203	204	205	206	207	208	209	210	211
384	315	254	255	256	257	258	259	260	261	262	263	264	265	266
385	316	317	318	319	320	321	322	323	324	325	326	327	328	329
386	387	388	389	390	391	392	393	394	395	396	397	398	399	400

Relating the square to the price chart showing geometric lines, the first support level is seen to be exactly at 240 (upper left diagonal), the major resistance at 276 (right horizontal), the next minor support at 268 (lower right diagonal), congestion area support at 254 and 262 (1 box off), and back down to support at 240. Notice that the distance between the lines

on the square becomes wider as prices increase, conforming to the notion of greater volatility at higher prices. it is also expected that soybeans at \$10 will have some lost motion near these key support and resistance levels.

The Hexagon Chart

Gann generalized his squaring method to include both geometric angles and the main cyclic divisions of 360'. By combining these different behavioral concepts, the strongest levels of support and resistance are found where all three coincide. The generalized construction for this purpose is the Master Calculator, based on aligning the chart at a point representing a multiple of the lowest historic price for that market; crisscrossing angles

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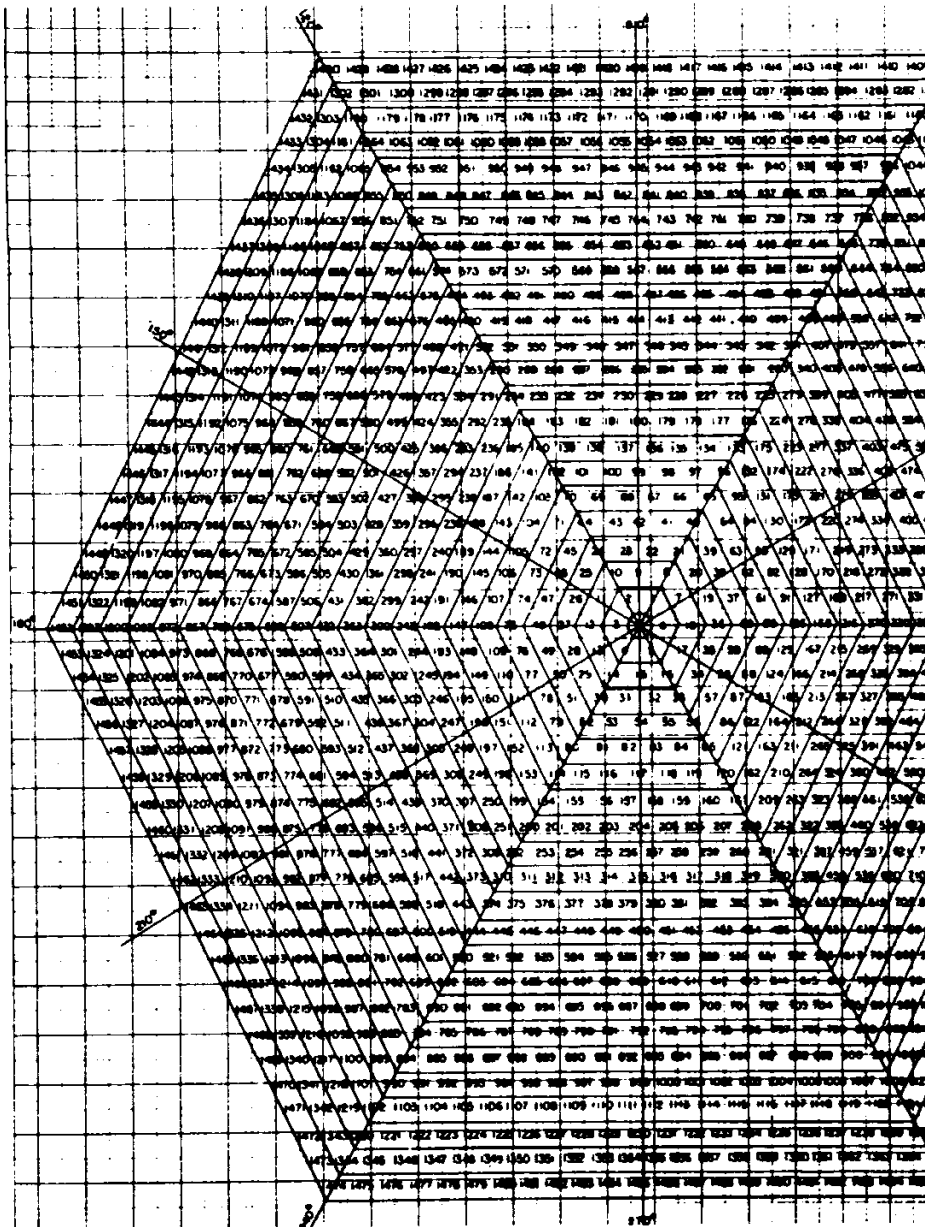
will then designate support and resistance for the specific market. Other time charts of importance are the Square of Twelve (one corner of the Master Calculator), the Hexagon Chart, and the Master Chart of 360'. The Hexagon Chart can be used as an example of the combined effect.

As shown in Figure 1420, the inner ring begins with six divisions, giving Gann the basis for the chart name. Each circle gains six additional numbers as it proceeds outward, which relates to the overall continuity of the construction. In using the hexagon, the degrees represent time and the numbers in the circle are price; a major support or resistance point exists when both time and price occur simultaneously.

For example, consider the 360' of the hexagon relating to the calendar year, or perhaps the crop year for grains. In his own work on grain, Gann equated 0' to March 20, near to the first day of spring when the sun crosses the equator going north. Then, the 45' line is on May 6, 90' on June 21 (the first day of summer), 180' on September 23 (fall), and 270' on December 21 (winter). These primary divisions also represent the most significant places for price support and resistance. The other lines represent secondary levels.

When looking at price and time together on the Hexagon Chart, the distance between the major degree lines becomes greater as prices increase showing the importance of

FIGURE 1420 The Hexagon Chart.



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volatility Using the price of November 77 soybeans, the chart shows that between 90' and 1800, or june 21 to September 23, 1977, the price of soybeans should have support at 567 and then move its major support level to 507 and its major resistance to 588 with next higher and lower support

and resistance at 432 and 675, respectively. As it turned out, this was a very accurate prediction.

On many of Gann's charts there is notation showing planetary movement, not related to the cycles of seasonality, but what is believed to be the Jupiter-Saturn cycle, discussed in the next section. These techniques make Gann's work more difficult to reproduce than most methods; his tools are less conventional than others. If Gann were asked for a word of advice, there is no doubt that he would caution to patience, stating: "When price meets time, a change is imminent."

FINANCIAL ASTROLOGY

Astrology seeks a common bond in human behavior, similar to the work in biological rhythms and cycles. The impact of astrology on civilization has been great; observations of the periodicity of the moon is traced back 32,000 years. Star charts were known to have been in Egypt about 4200 B.C., and the earliest written ephemerides were in the seventh century B.C. The pyramids at Giza are said to have sloping corridors leading from the faces to the interior that were used as sighting tubes for Egyptian astrologers for making accurate forecasts. The acceptance of astrology throughout history is widespread, including virtually all civilizations.

Even sophisticated analysts have been found to confuse astrology with the daily horoscope found in a local newspaper. Astrology, the interpretation of the effects of planets and stars on human affairs, is an art followed by a large portion of the world population and should not simply be discarded as mystical or occult. Interpretation of these effects can be complex and involves special skills. Most forecasts begin with a birth chart, which describes the position of the stars at the time of inception, then look at the current positions to identify the transitions. Over time, planets have taken on an association with specific raw goods, and constellations are associated with certain types of business; these relationships can now be verified using computer programs that check the intricate position of the planets with the financial statistics of companies to find a correlation. However, that task will be left for the more ambitious.

We must all agree that the positions of the planets and sun those bodies with the largest gravitational pull on the Earth and each other have clear physical effects. In the study of physics, this relationship is given as

$$\text{Force of attraction} = \frac{\text{Gravitational constant} \times \text{Mass}_1 \times \text{Mass}_2}{\text{Distance between them}^2}$$

where the gravitational constant is 6.67×10^{-11} , the mass is found in Table 141, and the distance between the centers can also be calculated from Table 141.

Of these physical effects, the seasons and the tides are undeniable; and there is much more when you study astronomy, the science of motion

of the stars and planets. In this section we will concentrate our attention on the physical phenomenon of planetary motion which can be identified and tested with the same confidence, and perhaps more, as other trading systems. Among these phenomena, eclipses and the lunar cycles are the most obvious, but there is one other combination that is important, the JupiterSaturn cycle.

11 Computer software is available for calculating and plotting much of Gann's works. See "Ganntrader L" Technical Analysis of Stocks & Commodities (January/February 1984), or contact Gannsoft Publishing Co., 3 11 Benton St., Leavenworth, WA 98826, or LambertGann, PO. Box 0, Pomeroy, WA 99347.

16 Derek Parker and Julia Paricor, *The Complete Astrologer* (McGrawHill, New York, 1971, p. 12).

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The JupiterSaturn Cycle

Jupiter and Saturn combine to represent the overwhelmingly largest mass, other than the Sun, in our solar system (see Table 145). The two planets amount to about 95% of the total mass of all the planets and are about .7% of the mass of the Sun. Because they are in adjacent orbits, they have a very large gravitational pull on other planets when they are near one another, and very different effects when they move apart. They are so large that they cause the Sun to shift periodically based on their positions around the true center of mass of the solar system, called the barycenter. When Jupiter and Saturn are on opposite sides of the Sun, the center of mass is near the center of the Sun, but when the two large planets are together, the Sun is pulled away from this center. This positioning also has significant effects on the Earth's climate, which in turn affects agricultural production, supply and demand, and finally the economy. The Greeks called the JupiterSaturn cycle "The Great Maker of Time," and it is said that every significant cycle in stocks, commodities, and interest rates is either a multiple or a harmonic of the JupiterSaturn cycle. The most wellknown, the 59year Kondratieff, is three times the JupiterSaturn cycle ($3 \times 19.859 = 59.577$). Gann, who used a combination of time and price, based time expectations on seasonality and cycles. His work referred to a "Master Time Factor" that was never defined, but experts believe that the JupiterSaturn cycle satisfies his technique.

Charting the Saturn Line

Having decided that the movement of the largest planets affects the way markets move, you can create a planetary envelope based on Saturn's path with respect to the Dow Jones Industrials and find frequent concurrence. This requires converting the position of the planets into price. When completed, this envelope is treated as support and resistance lines in a manner similar to the standard charting interpretation, in which penetration of a resistance line will become support; however, in appearance, the Saturn lines are curved to represent its cycle (see Figure 1421).

For a complete discussion of this topic, see Henry Weingarten, *Investing by the Stars* (McGrawHill, 1996). A section written by Richard Mogey, "Long Cycles and the Master Time Factor," is the basis for the next section.

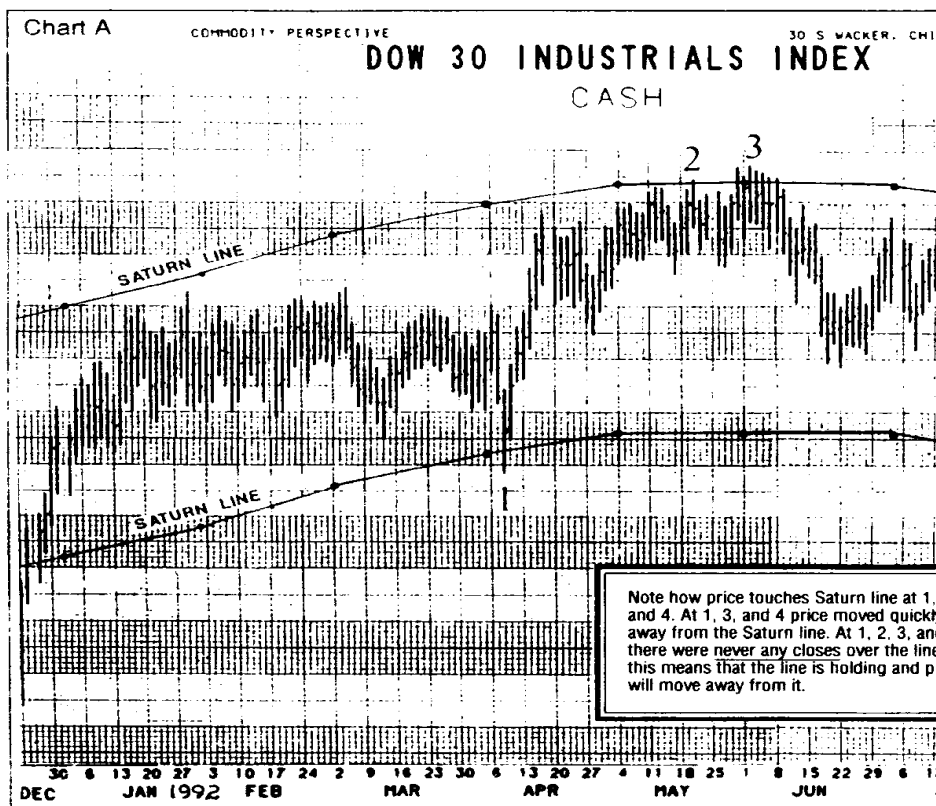
38 Jeanne Long, "Planetary Support and Resistance on the DJIA," *A Traders Astrological Almanac* 1994 (Professional Astrology Service, 757 S.E. 17th St., Ft. Lauderdale, FL 33316).

TABLE 14.5 Size and Position of the Planets and Earth's Moon

	Equatorial Diameter (km)	Mass* (kg)	Distance from Sun (mil km)
Sun	1,392,000	1.99×10^{30}	0
Mercury	4,880	3.34×10^{23}	57.9
Venus	12,102	4.87×10^{24}	108.0
Earth	12,756	5.98×10^{24}	149.6
Mars	6,794	7.35×10^{22}	227.9
Jupiter	142,800	8.39×10^{27}	778.3
Saturn	120,000	5.00×10^{27}	1,427
Uranus	52,000	3.77×10^{26}	2,870
Neptune	47,500	3.29×10^{26}	4,497
Pluto	2,500	5.98×10^{22}	5,893
Earth's moon	3,476	7.34×10^{22}	384,400 k

* Note that $mass = volume \times density$ and, except for the Earth and the Earth's moon, the density of the planet is assumed to be the same as the Earth's.

FIGURE 1421 Saturn lines drawn on the Dow Industrial.



Source: Jeanne Long, *A Traders Astrological Almanac* (1994). Reprinted with permission from PAS, Inc. Email: pas@bga.com Web Site: www.galacticinvestor.com.

Converting Planet Position to Price

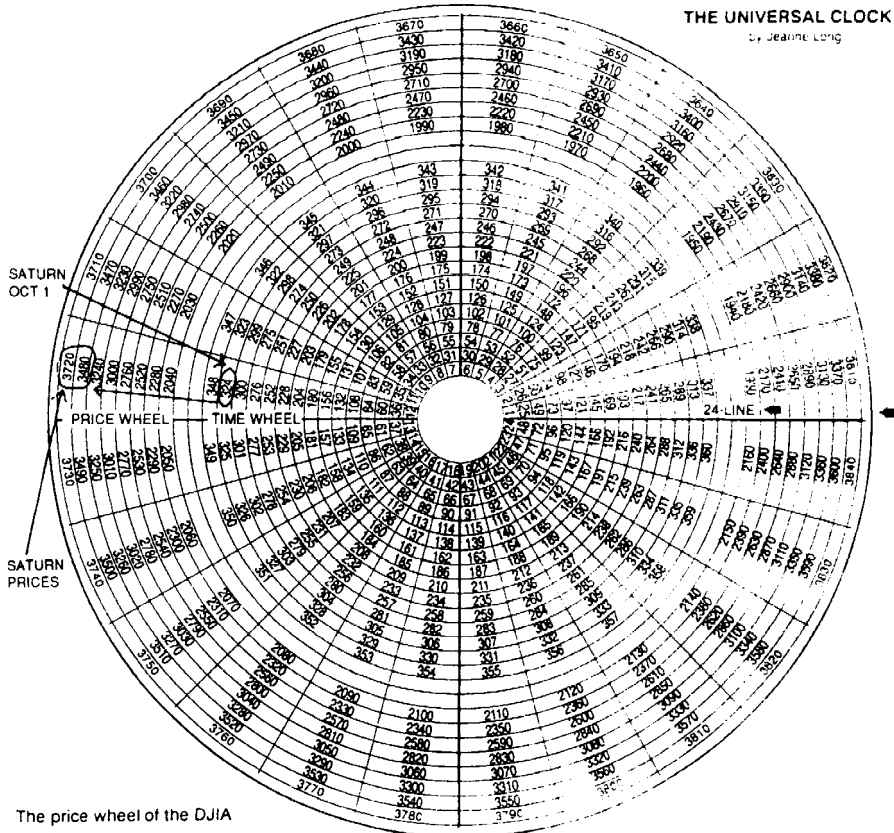
Long transforms planetary position to price using two separate wheels, combined to form a Universal Clock, in a manner similar to WD. Gann. Each wheel refers to a specific market. To create the Universal Clock for the DJIA, you begin above the right horizontal (at 3 o'clock) with the number 1 and move counterclockwise, placing 6 numbers per quarter and 24 for an entire cycle. You then move to the next outer circle and continue with the number 25 just outside the original number 1; therefore, each concentric circle contains the next 24 values, ending at 360 (a full cycle). The DJIA Clock is shown in Figure 1422.

in the outer wheel of the clock, the DJIA is shown in increments of 10 points beginning at 1930 and continuing in circles of 24 values. Long does not explain the choice of the beginning price, but Gann uses a significant low, and astrologers tend to use the price at a key starting time, such as the beginning of a new Dow calculation, birth of an exchange, or transforming event.

To locate the planet on the time wheel, begin with the planet's position on a specific date. For example, on October 1, 1993, Saturn was at 24' (with respect to Aquarius) 14'. Aquarius falls between 300' and 330'.

therefore, the position of Saturn is $3000 + 240 + 14' =$ approximately $324'$. By locating 324 on the inner part of the wheel, you can refer to the prices on the outer part of the wheel and find the two prices (each in adjacent circles) that

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FIGURE 1422 The DJIA Clock.



Source: Jeanne Long, A Traders Astrological Almanac (1994). Printed with permission from PAS, Inc.
E-Mail: pas@bga.com Web Site: www.galacticinvestor.com.

span the current DJIA price. These values are the current support and resistance lines. New values are found monthly.

Major Physical Events

Of the major physical phenomena used in financial astrology, the most important are:

Solar eclipsewhen the moon passes between the Earth and the Sun

Lunar eclipsewhen the Earth passes between the moon and the Sun

Conjunctionwhen any two planets are on the same side of the Sun (and form a straight line with the Sun)

Oppositionwhen two planets are on opposite sides of the Sun (and form a straight line with the Sun)

The physical significance of an eclipse is said to be that it disrupts the flow of energy between two bodies by the interference of a third mass. In actuality, the gravitational forces of the two bodies are maximized when they are both on one side of the Earth, as in a solar eclipse, and minimized when they are on opposite sides, as in a lunar eclipse. Tables 146, 147, and 148 give the dates of the primary physical events for Jupiter and Saturn, lunar and solar eclipses, and new and full moon eclipses.

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in astrology, the angles between planets are viewed from the position of the Earth; this is called a geocentric system. When a planet lies on the line between the Earth and Sun, it is in a geocentric conjunction; when it is aligned behind the Earth, it is in geocentric opposition. When a planet is at 90° to the Earth-Sun line, it is said to be square. 11 The angle that the planets form with the Earth-Sun line are called aspects. For the purposes of trading, squares are considered bearish while conjunctions and oppositions are bullish; however, there are other interpretations. Conjunction and opposition may not always conform to the strict definition of forming a straight line with the Sun, but may refer instead to close proximity. Both solar and lunar eclipses are conjunctions.

Trading on Aspects

Although the clearest physical phenomena combine the sun, moon, and largest planets when they are in conjunction and opposition, there are many other combinations of planetary positions that are considered important. It may also be necessary to follow a planet from the 90° to 270° position so that you track its effect on prices through the most extreme 180° path. The calculations for lunar and solar eclipses appear at the end of this chapter, but automatically calculating the aspect of combinations of planets would be beyond the ability of even the most computer-literate traders; commercial software is available for this level of detail and can calculate the number of occurrences that an aspect corresponds to a price move or price peak of a minimum size. The simplest method is to select days that represent swing highs or lows and record the major aspects. The larger the

19 Hans Hannula, *Trading Planetary Eclipses*, "Technical Analysis of Stocks & Commodities" (April 1992).

TABLE 146 Jupiter and Saturn Planet RX and Stations, 1996-2001 *

	<i>Jupiter</i> (Retrograde)	<i>Jupiter</i> (Direct)	<i>Saturn</i> (Retrograde)	
1996	May 4	Sep 3	Jul 18	Dec
1997	Jun 9	Oct 8	Aug 1	Dec
1998	Jul 18	Nov 13	Aug 15	Dec
1999	Aug 25	Dec 20	Aug 30	
2000	Sep 29		Sep 12	Jan 1
2001	Nov 2	Jan 25	Jan 24, Sep 26	(Satu
2002		Mar 1		Feb 8

*Source: Weingarten, *Investing by the Stars*.

TABLE 147 Eclipses, 19962001 *

	<i>Lunar Eclipse</i>	<i>Solar Eclipse</i>	<i>Lunar Eclipse</i>
1996	Apr 4	Apr 17	Sep 2
1997	Mar 24	Mar 9	Sep 1
1998	Mar 13	Feb 26	Aug 8
	Sep 6		
1999	Jan 31	Feb 16	Jul 28
2000	Jan 21	Feb 5	Jul 16
		Jul 31	
2001	Jan 9	Jun 21	Jul 5
	Dec 30		

*Source: Weingarten, *Investing by the Stars*.

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TABLE 148 New and Full Moons, Eclipses 19962001*

	<i>New</i>	<i>Full</i>	<i>New</i>	<i>Full</i>	<i>New</i>	<i>Full</i>	<i>New</i>	<i>Full</i>	<i>New</i>
1996		Jan 5	Jan 20	Feb 4	Feb 18	Mar 5	Mar 19	Apr 4	Apr 18
	Jun 16	Jul 1	Jul 15	Jul 30	Aug 14	Aug 28	Sep 12	Sep 27	Oct 11
	Dec 10	Dec 24							
1997	Jan 9	Jan 23	Feb 7	Feb 22	Mar 9	Mar 24	Apr 7	Apr 22	May 6
	Jul 4	Jul 20	Aug 3	Aug 18	Sep 1	Sep 16	Oct 1	Oct 16	Nov 1
1998		Jan 12	Jan 28	Feb 11	Feb 26	Mar 13	Mar 28	Apr 11	Apr 25
	Jun 24	Jul 9	Jul 23	Aug 8	Aug 22	Sep 9	Sep 20	Oct 5	Oct 19
	Dec 18								
1999		Jan 2	Jan 17	Jan 31	Feb 16	Mar 2	Mar 17	Mar 31	Apr 14
	Jun 13	Jun 28	Jul 13	Jul 28	Aug 11	Aug 26	Sep 9	Sep 25	Oct 9
	Dec 22								
2000	Jan 6	Jan 21	Feb 5	Feb 19	Mar 6	Mar 20	Apr 4	Apr 18	May 2
	Jul 1	Jul 31	Aug 15	Aug 29	Sep 13	Sep 27	Oct 13	Oct 27	Nov 10
2001		Jan 9	Jan 24	Feb 8	Feb 23	Mar 9	Mar 25	Apr 8	Apr 22
	Jun 21	Jul 5	Jul 20	Aug 4	Aug 19	Sep 2	Sep 17	Oct 2	Oct 16
	Dec 14	Dec 30							

*Source: Weingarten, *Investing by the Stars*.

swings, the more significant the results. By creating a table of key reversal levels, it may be possible to find those aspects that exert the greatest influence on the market. Once isolated, they may be used as a bias within a

technical program.

The Moon: Buy Full, Sell New

it is known that the moon's effect on our planet is great it is vitally connected. with the movement of all fluids. The mass of the moon is about 1/81 that of the Earth and larger than the planet Pluto. It is remarkably large for a moon, with a diameter of 3,476 kilometers, 27% that of the Earth. Because of its large presence and close proximity to the Earth (about 230,000 miles), the moon is also believed to affect human behavior in strange ways, especially during a new or full moon.

In an experiment conducted on an arbitrary set of futures markets for the year 1972,¹ it was shown that shortterm movements of prices react with some uniformity with respect to the phases of the moon. in fact, the markets chosen for observationsilver, wheat, cattle, cocoa, and sugarshowed an uncanny ability to form a rising market following a full moon and a falling market after a new moon.

To find the phases of the moon, you can refer to a number of books or any calendar; however, to perform any lengthy study of the moon's effect on prices, the moon's phases should be computerized. An Easy Language function that gives the dates of the new and full moon follow.

Calculation of a New Moon, Full Moon, Solar and Lunar Eclipse

Although a highly accurate calculation of planetary positions and eclipses requires consideration of many minor items, a good approximation can be found with far less difficulty`

¹ Todd Lofton, "Moonlight Sonata," *Commodities* (July 1974).

⁴¹ Jean Meeus, *Astronomical Algorithms* (Willmann-Bell, Inc., PO. Box 35025, Richmond, VA 23235, 1991, Chapter 52). A shorter version appears in another volume, *Astronomical Formulae for Calculators*, Fourth Ed. (1988). For complete accuracy, the author refers readers to the *Astronomical Almanac*, or the *Canon* by Mucke and Meeus. The material in this section combines both versions of Meeus's work.

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To calculate the exact time of the eclipses, it is first necessary to find the time of the new and full moons. The resulting times are expressed in Julian Ephemeris Days (JDE), also called dynamic time (DT).

Lunar Phases

The new and full moons are simply two of the four lunar phases, measuring when the excess of the apparent longitude of the moon over the apparent longitude of the Sun is 0°, 90°, 180°, and 270°. The times of these phases are given by the julian date:

$$1. \text{ JDE} = 2451550.09765 + 29.530588853k + 0.000000150T^3 + 0.00000000073T^4$$

where an integer value of k gives the new moon (i.e., 1, 2, 3), and an integer value increased by .25, .50, or .75 (e.g., 1.25, 1.50, 1.75) gives the three quarters, respectively. The value k = 0 corresponds to the new moon of January 6, 2000. Negative values indicate times prior to the year 2000. T is the time in julian centuries since 2000, found by $T = k/1236.85$,

To check your results, k is approximately equal to (year - 2000) x 12.3685

and the year is expressed in decimal (e.g., the end of March 1997 is 1987.25)

Using this formula, we can get a list of dates for the full moon from about 1995 through the year 2000 (approximately 62) by creating an array called JDE and finding the 62 dates of the new and full moons ending at the year 2000 using the TradeStation code as shown in Figure 1423.

For each value of k in the previous program, corrections must be made to find the exact time of maximum solar or lunar eclipse using the following values:

2. Eccentricity of the Earth's orbit around the Sun:

$$E = 1 - 0.002516T - 0.0000074T^2$$

3. The Sun's mean anomaly at time JDE:

$$M = 2.5534 + 29.10535669k - 0.0000218T^2 - 0.0000000150T^3$$

FIGURE 1423 TradeStation function to calculate the moon's phases.

{MOONPHASES

Returns the mean phases of the moon, corrected

VARs: k(0), t(0), next(0), i(0);

ARRAY fullmoon[62](0), newmoon[62](0);

next = -62;

for i = 1 to 62 begin

k = 2000 + next; {newmoons rela

T = k / 1236.85; {time in Julia

newmoon[i] = 2452550.09765 + 29

+ 0.0001337*@power(T,2);

-0.000000150*@power(T,3) +

k = 2000 + next + .5; {full moons

T = k / 1236.85;

fullmoon[i] = 2452550.09765 + 2

+ 0.0001337*@power(T,2)

-0.000000150*@power(T,3) +

next = next + 1;

end;

4. The moon's mean anomaly:

$$M' = 201.5643 + 385.81693528k + 0.0107438T^2 \\ + 0.00001239T^3 - 0.000000058T^4$$

5. The moon's argument of latitude:

$$F = 160.7108 + 390.67050274k - 0.0016341T^2 \\ - 0.00000227T^3 + 0.000000011T^4$$

6. The ascending node of the lunar orbit:

$$\Omega \text{ (Omega)} = 124.7746 - 1.56375580k + 0.002069$$

7. The eccentricity of the Earth's orbit around the Sun:

$$E = 1 - 0.002516T - 0.0000074T^2$$

8. The following calculation, based on F and Ω , gives the eclipse; and if F differs from 0° , 180° , or 360° by less than 21° from these phases, the difference between these values then there is no eclipse if $|\sin F| >$

The next components needed for corrections are:

$$F_1 = F - 0^\circ.02665 \sin \Omega$$

$$A_1 = 299^\circ.77 + 0^\circ.107408k - 0.009173T^2$$

9. Then to find the exact time of the full solar (or lunar) eclipsions (in days) should be added to the time of the mean in the first formula above (smaller quantities have been

Time of maximum eclipse

$$= \text{JDE} + (\text{lunar or solar component below})$$

$$+ 0.0161 \sin 2M' - 0.0097 \sin 2F_1 + 0.0073 \times \\ - 0.0050 \times E \times \sin (M' + M) - 0.0023 \sin (M' \\ + 0.0012 \sin (M' + 2F_1) + 0.0006 \times E \times \sin (2 \\ - 0.0003 \times E \times \sin (M + 2F_1) + 0.0003 \sin A_1 \\ - 0.0002 \times E \times \sin (2M' - M) - 0.0002\Omega$$

$$\text{solar component} = -0.4075 \sin M' + 0.1721 \times E \times \sin A_1$$

$$\text{lunar component} = -0.4065 \sin M' + 0.1727 \times E \times \sin A_1$$

10. $P = 0.2070 \times E \times \sin M + 0.0024 \times E \times \sin 2M - 0.039 \\ - 0.0073 \times E \times \sin (M' + M) - 0.0067 \times E \times \sin (M$
 11. $Q = +5.2207 - 0.0048 \times E \times \cos M + 0.0020 \times E \times \cos \\ - 0.0060 \times E \times \cos (M' + M) + 0.0041 \times E \times \cos ($
 12. $W = |\cos F_1|$
 13. $\gamma \text{ (gamma)} = (P \cos F_1 + Q \sin F_1) \times (1 - 0.0048W)$
 14. $u = 0.0059 + 0.0046 \cos M - 0.0182 \cos M' + 0.0004 \cos$

For a solar eclipse, y represents the shortest distance from the axis of the moon's shadow to the center of the Earth in units of the equatorial radius of the Earth (the distance from the center to the surface of the Earth at the equator). Its value is positive if the axis of the shadow is passing north of the Earth's center, and negative if it is passing south. When y is less than +.9972 and greater than -.9972, the solar eclipse is central, that is, there is a line of central eclipse on the surface of the Earth (see Figure 1424).

The value u gives the radius of the moon's umbral cone on the fundamental plane, which passes through the center of the Earth perpendicular to the axis of the moon's shadow (in units of Earth's equatorial radius). The radius of the penumbral cone in the fundamental plane is $u + .5460$.

Based on these values, the following situations exist:

$|\gamma|$ is between 0.9972 and 1.5432 + u **The eclipse is total.**

$|\gamma|$ is between 0.9972 and 1.0260 **Part of the eclipse is visible in both regions.**

$0.9972 < |\gamma| < 0.9972 + |u|$ **The combination of partial and annular eclipse is visible.**

$|\gamma| > 1.5432 + u$ **No eclipse is visible on the Earth's face.**

For a central eclipse,

$u < 0$ **The eclipse is total.**

$u > 0.0047$ **The eclipse is annular.**

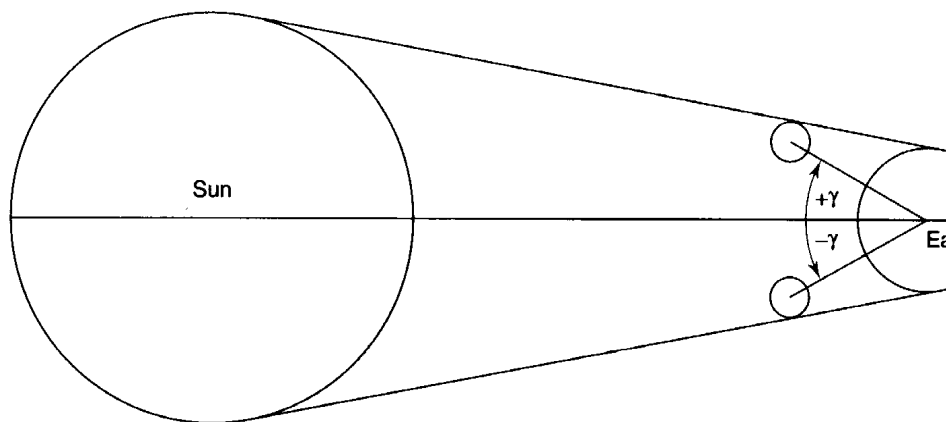
$0 < u < 0.0047$ **The eclipse is partial or total.**

To remove the ambiguity of this last situation, calculate

$$\omega = 0.00464 \cos W, \quad \text{where } \sin W = \gamma$$

If $u < \omega$ then the eclipse is annular-total; otherwise, it is annular.

FIGURE 1424 Geometry of a solar eclipse.



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The greatest magnitude for a partial solar eclipse is reached at the point on the Earth's surface that comes closest to the axis of the shadow at

$$\text{Greatest magnitude of solar eclipse} = \frac{1.5433 + u - |\gamma|}{0.5461 + 2u}$$

Lunar Eclipses

For a lunar eclipse, γ is the least distance for the center of the moon (see Figure 14-25). The value γ is positive if the moon's center is passing north of the shadow, and negative if it is passing south. At the distance of the moon's orbital radius $\rho = 1.2847 + u$ and the umbra radius $\sigma = 0.7404 - u$. The eclipse is

$$\text{penumbral eclipses:} \quad (1.5572 + u - |\gamma|) / 0.5450$$

$$\text{umbral eclipses:} \quad (1.0129 - u - |\gamma|) / 0.5450$$

If the magnitude is less than zero, there is no eclipse. The *semiduration* of the total phases in the *umbra* are calculated as

$$P = 1.0129 - u$$

$$T = 0.4679 - u$$

$$n = 0.5458 + 0.0400 \cos M'$$

and the semidurations in minutes are

$$\text{partial phase} = \frac{60}{n} \sqrt{P^2 - \gamma^2}$$

$$\text{total phase} = \frac{60}{n} \sqrt{T^2 - \gamma^2}$$

Example: Solar eclipse of May 21, 1993:

The following values can be used to verify your calculations:

May 21 is the 141st day of the year, therefore

$$k = 1993 + 141/365 = 1993.38$$

$$T = 1993.38/1236.85 = 1.6116.$$

$$\text{JDE} = 2449128.5894$$

FIGURE 1425 Geometry of a lunar eclipse.

